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ABSTRACT

This study resulted from an on-going evaluation of the 2-year engineering related technology curricula at Illinois Central College. The purpose of the research was to determine the appropriate course content for technical physics and mathematics, the level of theory to be taught, instructor qualifications, and the appropriate department for offering these technical courses. Areas of inquiry included: (1) attitudes held by experts in the field of technical education toward the teaching of technical physics and mathematics courses; (2) current practices in Illinois junior colleges, and (3) courses being offered in the Mathematics and Science Division and in the Engineering and Industrial Occupations Division at Illinois Central College. It was found that specialized courses in mathematics and physics for technology programs should emphasize an applied rather than theoretical approach, instructors teaching these courses should be sympathetic to technical education and have had industrial experience, technical mathematics and physics courses should be offered in the technology department, and entering students with deficiencies should have greater psychological support. (AL)

AN ANALYSIS OF THE PRACTICES IN THE TEACHING OF TECHNICAL MATHEMATICS AND TECHNICAL PHYSICS IN ILLINOIS JUNIOR COLLEGES

PHASE I

A Research Paper

Presented to

Glendon O. Arvin

Bradley University

In Partial Fulfillment

of the Course Requirements of

Industrial and Technical Education 602

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by

Betty Doversberger

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PREFACE

The mathematics and physics courses for engineering-related technology curricula form the foundation for the technical specialties. It is important that they be taught in accordance with the philosophy of technical education, and that the students acquire the basic science skills on which they must build.

Junior colleges are faced with the problem of how best to satisfy these requirements. Questions such as appropriate course content, level of theory, and qualifications of instructors and in which department the courses should be taught must be answered.

This study resulted from an on-going evaluation of the two-year engineering-related technology curricula at Illinois Central College. In searching for answers to questions such as those mentioned above, it was found that little research has been done on this subject. It was therefore decided to undertake this study in the hope that it might prove of interest, only only to Illinois Central College, but to other Illinois junior colleges as well.

Any value it may have to others can never equal the benefit it has brought to the author. The research involved in preparing this report has broadened and crystallized my understanding of technical education immeasurably, and has shaped my teaching philosophy.

Because of the magnitude of the study, it was divided into two phases, which required nine months for completion. The report, therefore, appears in two separate sections.

The study would have been impossible without the cooperation of the 29 Illinois junior colleges and the 13 technical institutes which participated. Particularly valuable were the assistance, advice, guidance and moral support given by Professor Glendon O. Arvin and Professor John E. Dalton of Bradley University, under whom I was doing graduate work at the time, and to whom this report was submitted.

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DELINEATION OF THE PROBLEM

I. STATEMENT OF THE PROBLEM

Recently it has been questioned at Illinois Central College whether the engineering and industrial technology curricula should include specialized technical mathematics courses, and if so, whether these courses should be offered in the Engineering and Industrial Occupations Division or in the Mathematics and Science Division. A study has therefore been made of this subject.

The problem can be broken down into the following basic questions: (1) Should mathematics courses for the engineering and industrial occupations programs be taught differently from mathematics for transfer programs? (2) Should mathematics for engineering and technology programs be taught by mathematics specialists, or by the technology faculty? (3) Are there courses presently being offered in the Mathematics and Science Division at Illinois Central College which satisfy the requirements of the technology curricula? (4) Would the integration of students in the engineering and industrial technology curricula into the student body be better accomplished if the mathematics courses for these curricula were taught in the Mathematics and Science Division?

II. SIGNIFICANCE OF THE STUDY

One of the important functions of the junior college is to provide technical education at less that four-year degree level for those students who want to enter the work force immediately as technicians. This responsibility was for many years carried by the technical institutes. Rapid advancements in

technology since World War II have proliferated the need for technicians. The simultaneous increase in the number of junior colleges has made their assumption of this task a natural development. Some authorities consider occupational education to be the most distinctive and important function of the junior college. Medsker has stated that the community college is the logical agency to provide training for mid-level occupations, and that unless the junior college meets this responsibility, there will be an unfortunate need to develop another type of institution to assume this task.[1]

Every effort should be made to offer the highest possible quality of technical education in the junior college. Studies which provide information about the accepted practices in technical education can be helpful in this search for quality.

No studies can be found which deal directly with the questions posed in this paper. No standard practice has developed in Illinois junior colleges regarding the mathematics courses for technology programs. It is hoped, therefore, that this study will not only be useful for Illinois Central College, but will also be of interest to other junior colleges in the state.

III. LIMITATION OF THE STUDY

Technology curricula consist of four types of courses; technical specialties, technical skills, basic sciences (including mathematics), and general education courses.

This study is concerned only with the basic science courses of engineering

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[1]Leland L. Medsker, The Junior College: Progress and Prospect (New York: McGraw-Hill Book Company, 1960), p. 117.

and industrial technology curricula, and attempts to find answers to the specific questions which have been posed above. Although the primary emphasis is on mathematics courses, the study also examines the closely related topic of physics courses for technology curricula.

IV. DEFINITION OF CRITICAL TERMS

Much confusion exists regarding terminology in technical education. The exact usage in any particular paper must therefore be specified.

Technical Education will, in this paper, refer only to that segment of education at a post-high school level which offers training at the Associate Degree level in technical occupations. It will not refer to four-year technology programs or one-year certificate programs.

Technical Institute is used by some authors to refer to any institution offering technical education as defined above, whether it is an institution with this as its sole purpose, a branch or division of a university, or the technology department of a junior college. When these sources are quoted, the term will be used in this sense. The term is more generally used to refer only to those institutions which exist for the primary purpose of offering Associate Degree level technical education. In all other parts of this paper, the term will be used in this more limited sense.

Technology Curricula or Programs will be used in this paper to replace the more wordy phrase, engineering and industrial technology curricula or programs. Although many other types of technology programs exist, they are not being considered in this paper, and no ambiguity should result from the use of the abbreviated term.

Technical Mathematics will refer to those mathematics courses, specially designed for technology curricula, which feature combinations of selected topics and extensive use of applications.

V. METHODOLOGY

Two sources of information have been explored for this study, the opinions of experts in the field of technical education, and present practices in the Illinois junior colleges. In addition, attitudes and backgrounds of students in Illinois junior colleges, and of faculty in these schools and in selected technical institutes were investigated.

Every effort was made to find all available references pertinent to this study. The card catalog of the Bradley University library was searched for titles relating to technical education; all promising books were examined for relevant comments. Once the appropriate sections of the library had been identified, other books on those shelves were also examined. A bibliography pertaining to industrial-technical education was obtained from Glendon O. Arvin, Associate Professor of Mechanical Technology at Bradley University, and all available books from this bibliography were examined. A visit was made to the General Engineering Department of the University of Illinois, and their extensive library relating specifically to technical education was searched for references. The Education Index and the Educational Resources Information Center (Eric) Index were searched for titles of pertinent articles and studies; this approach did not prove fruitful, however, and after a number of articles had been examined without finding any relevant information, these sources were abandoned.

Many of the books dealing with technical education did not discuss the subject of the basic science courses. It was, however, possible to find a number of books and dissertations dealing with this topic. Outstanding

unanimity of opinion was found among the experts in the field. A strikingly clear picture emerged because of the remarkable agreement among authorities.

The technical institutes have long been leaders in technical education. These institutions have been able to develop their technology programs with attention devoted exclusively to the quality of such programs, unaffected by problems relating to transfer curricula. Studies of the technical institutes were therefore found to be particularly useful.

Practices in selected Illinois junior colleges have also been investigated. Three of the leading experts in the state of Illinois were contacted and asked to identify those Illinois junior colleges which have outstanding engineering-related technical programs. Geographically separated, these men did not communicate with each other in making their selections. Of the twelve schools selected by all three men, eight responded in time to be included in the study. A questionnaire was sent to all junior colleges in the state, and the practices in the schools selected as outstanding were compared with those in other schools throughout the state. The purpose of the questionnaire was twofold: it inquired whether technical mathematics and technical physics are taught, in what department they are offered, and whether industrial experience is sought in hiring instructors for these courses; it also requested cooperation with later phases of the study.

The mathematics and physics courses presently being offered in the Mathematics and Science Division and the Engineering and Industrial Occupations Division at Illinois Central College have been compared, to determine their similarities and differences. The advantages and disadvantages of teaching the mathematics and physics courses for the technology programs in the Mathematics and Science Division have been assessed.

The second phase of the study followed the opening of the fall semester. Further questionnaires were sent to those schools which agreed to distribute them. These questionnaires were designed to explore the attitudes of instructors in mathematics, science, and technology departments toward the purposes of the junior college, toward students in transfer and terminal curricula, and toward both technical and "pure" courses in the basic sciences. The level of industrial experience sought in hiring instructors of technical mathematics and physics was also investigated. A similar set of questionnaires was sent to faculty in some of the outstanding technical institutes. A third set of questionnaires explored the attitudes and aspirations of students in both transfer and occupational curricula in the junior colleges. Results of these questionnaires are presented in the second phase of this study.

CHAPTER II

REVIEW OF THE LITERATURE

Comments of the experts in the field of technical education can be divided into two categories; those dealing with the course content of the basic sciences and the method by which they should be taught, and those dealing with desirable characteristics of instructors of those courses. While the two areas overlap, they will be discussed separately.

I. DESIRABLE CHARACTERISTICS OF BASIC SCIENCE COURSES FOR TECHNOLOGY CURRICULA

Those who have studied technical education agree emphatically that the basic science requirements of technology curricula differ greatly from those of four-year or two-year transfer curricula, even in such a closely related field as pre-engineering.

Graney, who made a comprehensive study of technology curricula (using the term technical institute to refer to all institutions offering technical education), has stated:

> It must be clearly understood that technical institute curriculums are not designed to be pre-engineering curriculums. Typical engineering curriculums devote at least two full years to a study of mathematics, basic science, and general education before any serious attention is given to professional courses. The depth of study and degree of understanding an engineering student must have of these fundamental subject matter areas are thus considerably greater than can be expected from a technical institute student who must cover the same areas in half the time. This is the reason for great emphasis upon the careful selection of topics to be included . . . In designing the content of mathematics courses for the technical institute, the ultimate in consideration must be given to what the technology requires.[2]

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[2]Maurice R. Graney, The Technical Institute (New York: The Center for Applied Research in Education, Inc., 1964), p. 54.

Graney emphasizes that the topics selected for the technical mathematics cours will be an important determinant of the level of the technology programs, and therefore requires the greatest possible care. The requirements of different technologies will not be the same:

> The technology studied will determine the content of the technical specialty, and there are differences in the required mathematical underpinning of the several technical specialties. Electrical technology probably places the greatest demands upon mathematical knowledge. Others vary slightly, while some, such as industrial technology, may place the emphasis on different mathematical concepts.
>
> Selected topics from college-level algebra and college-level trigonometry are the first mathematics included in all technologies. From this point on, carefully chosen content from such areas of mathematics as analytic geometry, differential and integral calculus, differential equations, probability and statistics, vector algebra, and Boolean algebra may be required to support the technical specialty.[3]

The McGraw Report also stresses that technical mathematics courses require careful selection of the topics to be included. The same limitations of time which make topic selection so vital complicate the coordination of the mathematics with the technical courses. It becomes vital that there be close communication between instructors in these areas.

> The curriculum should be so arranged that principles are taught in the mathematics courses prior to the time they are needed in the technical courses. This requirement does not necessarily demand that all mathematics courses be completed before the student undertakes his technical courses. It does demand sufficient integration to assure that if the student is taking mathematics and technical courses concurrently a given mathematics topic will be covered in the mathematics course before its application is required in the technical courses. This may well necessitate rearrangement of topics within the mathematics courses in such a way as to differ from the traditional sequence.[4]

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[3] Ibid.

[4] "Characteristics of Excellence in Engineering Technology Education," The Evaluation of Technical Institute Education, American Society for Engineering Education, James L. McGraw, Project Director (Urbana: University of Illinois, 1962), p. 28.

In addition to specialized content, technical mathematics courses also require a specialized method of presentation. Again and again it is stressed in the literature that mathematics for technology curricula should be taught on an applied, rather than a theoretical, basis. Graney warns:

> The technical institute faculty member must be on guard against the understandable desire to pursue some segment of his subject matter to depths which are not required. In so doing, he may divert time from some other segment essential to the technician's proficiency. The purpose of the technical institute is not to prepare a student to carry on at a later date to the baccalaureate degree. If it were, the technical institute program would be a pre-engineering program. To understand this point and to gear instruction to the goals of the technical institute require a faculty which is not an engineering school faculty, but rather a technical institute faculty.[5]

The Engineering Council for Professional Development (ECPD), in establishing criteria for accreditation of technology curricula, has specified that the content of the curricula must be technological in nature, and that courses in the physical sciences and mathematics must be applied to practical problems.[6] Henninger, in a study of technical institutes in America, found agreement that technology curricula do not need the depth or extent of mathematical or scientific understanding needed in engineering curricula. They need, instead, an educational approach comparable in quality but differing in emphasis; in technology curricula, emphasis should be on "practical application of established mathematical, scientific, and technological principles rather than upon their derivation or theoretical development."[7] He went on to say:

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[5]Maurice R. Graney, op. cit., p. 78.

[6]Holland E. Boaz, Degree Level Technology Programs Offered in Industrial Education Departments: Their Status, Accreditation and Acceptance (Doctoral dissertation, University of Missouri, 1965), p. 98.

[7]G. Ross Henninger, The Technical Institute in America (New York: McGraw-Hill Book Company, 1959), p. 32.

> Technical institute mathematics is characteristically taught as a separate course independent of other technical subject matter. However, it is not taught in the abstract, as mathematics for mathematics' sake. Established principles and procedures are emphasized rather than theoretical derivations and proofs. Independence from other technical subject matter is tempered by appropriate coordination so that the student develops an appreciation of mathematics as a necessary and useful tool in the technology of his choice.[8]

In a study of the qualifications of technical teachers, Eno sent a twelve page questionnaire to engineering technology personnel in ten 2-year colleges in New York state. Two of the questions dealt specifically with the method of teaching the basic science courses for technology programs. In answer to the question, "Basic science courses in engineering technology programs (e.g. mathematics, physics, chemistry) should be taught as related subjects rather than as 'pure' subjects," the response was strongly positive, with the exception of the faculty teaching chemical technology. Eno abstracted the comments of participants in the study as follows:

> General agreement was apparent in the great majority of the comments. Most of the comments favored the teaching of the basic sciences with a focus on the engineering technology curricula with the exception of the chemical participants.[9]

The other pertinent question was, "The basic sciences (e.g. mathematics, physics, chemistry, etc.) should be taught as pure sciences." Answers to this question were strongly negative, with the instructors in chemical technology again dissenting with the majority opinion. Eno's abstract of the comments stated:

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[8] Ibid., p. 40

[9] Richard S. Eno, Sr., Qualifications for Technical Teachers in Engineering Technologies in New York State Two-Year Colleges and Facilities for Developing Such Teachers, (Canton, New York: Agricultural and Technical College, 1968), p. 60.

> By far, most of the "Con" comments expressed favor for the applied, the practical, the related approach to the teaching of science subjects. These comments were emphasized with considerations such as student interest and motivation.
>
> Engineering technologies are too vast to depend on general science approaches. The emphasis of all technical education should be on the abilities to think, analyze and organize.[10]

Graphs showing the breakdown of answers to these questions, taken from Eno's report, are found in Appendix A.

The most comprehensive study of basic science courses in technology curricula which has been found is that by Roney. The thirty-five ECPD accredited technology curricula which he studied represented almost one-third of the 118 such curricula accredited by the ECPD in 1961, when the study was initiated. Twelve schools offering two-year curricula participated in the study. Tape recorded interviews included the following pertinent questions:

> Are the mathematics courses in these [technology] curricula specialized to meet the requirements of technical curriculum or are they general in nature?
>
> To what extent are applications used in the teaching of mathematics?
>
> Is the emphasis in mathematics on the derivation of equations or on their use in the solution of problems?[11]

The detailed answers to these questions are extremely relevant to this study, but are too lengthy to include in the body of this report. They are given in full in Appendix B. Roney's conclusions, based on the answers to these questions and on other phases of his study, are as follows:

> 1. Mathematics courses of a general nature would not be adequate for the needs of engineering technology curricula. Such courses would lack the proper emphasis on specific topics needed in technical courses.

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[10] Ibid. p. 55.

[11] Maurice William Roney, An Analysis of the Interrelationship of Mathematics, Science, and Technical Subject Matter in Selected Technical Institute Curricula (Doctoral Dissertation, University of Maryland, 1964), pp. 53-54.

Mathematics courses designed to provide the prerequisites for advanced mathematics study would be inefficient and hence inappropriate for engineering technology curricula.

2. The efficacy of mathematics instruction in technology curricula was measured by the skill of students in using mathematics as a tool in the learning process. Mathematics courses, to produce this skill, were tailored to the specific needs of technology curricula. The transferability of mathematics course credit to advance degrees was not given major consideration in the design of mathematics courses.

3. The mathematics program in technology curricula concentrated on developing skills in using algebra and trigonometry in the solution of practical engineering problems. Extensive instruction in the mechanics of formula derivation was avoided. Special forms needed for higher mathematics study were not included in mathematics courses.[12]

Recongnition of the need for specialized mathematics courses for technology curricula is evidenced by the fact that all of the schools studied by Roney offered such courses. The specialization of the courses was achieved by selection of the topics to be included, and by stressing applications. Roney stated:

> Mathematics instruction was tailored to meet the specific needs of technology curricula in all of the technical institutes included in this study. No curriculum included a mathematics program that could be described as general or traditional college mathematics. No instance was found in which a mathematics course served both technical and non-technical curricula.[13]

The same attitudes which prevail toward mathematics courses also apply to physics courses for technology curricula. Graney states:

> Mathematics is not the sole determinant of curriculum level. The sciences also exert an important influence . . . . As was true in the study of mathematics, only selected topics can be included. These should be determined by the requirements of the technology and not defined by their more comprehensive counterparts in professional engineering curriculums.[14]

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[12] Ibid., pp. 133-134.

[13] Ibid., p. 103.

[14] Maurice R. Graney, op. cit., p. 55.

The McGraw Report comments that most of the observations made about the role of mathematics in the engineering technology curriculum apply equally to the physical sciences. In discussing the methods of teaching physics in technology curricula, Henninger quotes Harris as saying:

> Every opportunity is taken to make physics meaningful by a judicious selection of problems from industry . . . . The necessity for a strong program in physics at the pre-engineering level has long been recognized. Technician education demands an equally strong physics program, but it must be especially adapted to the needs of the technical institute student.[15]

Roney reached the following conclusions concerning physics courses in technology curricula:

> 1. Physics courses in technical curricula consisted of special topics selected on the basis of the need for these topics in technical courses. A complete program of college physics was considered too time consuming for the two-year program of instruction.
>
> 2. Instruction frequently included practical applications of physics principles in addition to the more traditional laboratory experiments commonly used in college courses.[16]

According to Henninger, the tendency in some schools to consolidate into fewer and larger units, giving common courses in general science for economic reasons is not to be recommended educationally.[17] Emerson stated that the weaknesses to be found in community college technology programs consist of:

(1) the academic approach to technical education followed by many junior college administrators;
(2) some domination of technician training by academic standards not pertinent to this type of education;
(3) confusion between technician training and pre-engineering training, and the tendency to utilize existing courses designed for transfer students as part of the technician training curriculum.[18]

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[15]N. C. Harris, "The Role of Physics in Technical Education," Technical Education News, April, 1955; cited by G. Ross Henninger, op. cit. p.41.

[16]Maurice William Roney, op. cit.,p. 135.

[17]G. Ross Henninger, op. cit., pp. 41-42.

[18]Lynn A. Emerson, A Summer Institute for the Improvement of Technical Teacher Education Programs, Final Report of Project 7-0528, U. S. Office of Health, Education and Welfare, November, 1967, p. 77.

II. DESIRABLE CHARACTERISTICS OF INSTRUCTORS OF BASIC SCIENCES FOR TECHNOLOGY CURRICULA

A study of the comments in the literature concerning the characteristics sought in instructors of the basic science courses of the technology curricula shows that three closely interrelated areas are of major concern. These areas are educational background, industrial experience, and attitude toward technology education. It is impossible to separate a discussion of the three.

With only one exception, experts in the field of technical education feel that all teachers in technology curricula should have received their education in engineering or science, should have had industrial experience, and above all should understand and be in sympathy with technical education. As stated in the McGraw Report:

> It is important that all members of the engineering technology faculty be familiar with and sympathetic toward the goals of this type of education. The engineering technology teacher must not only be conscious of a desire to teach his subject, but also to teach it at the engineering technology level. Unless the faculty has this quality an institution can easily find itself overloaded with teachers for whom engineering technology education is at best a secondary interest . . . .
>
> The principles just expressed apply equally to teachers of technical and non-technical subjects. It is in mathematics and the non-technical subjects, in fact, that we are likely to encounter the greatest misunderstanding of objectives. The implied problems are most prevalent in comprehensive institutions that offer engineering technology curricula but that draw indiscriminately on a common staff for teaching vocational, engineering technology, and baccalaureate courses.[19]

Even in the mathematics courses, the overwhelming consensus is that those who majored in mathematics do not make the best teachers for technology curricula. Roney, in his study, asked the question, "Are mathematics teachers specialists

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[19]"Characteristics of Excellence in Engineering Technology Education," op. cit., p. 16.

in mathematics or are they drawn from the staff of the technology department?" Six of the twelve schools participating responded to this question. Four of the six replied that they did not use mathematics majors to teach the mathematics courses for the technology curricula because they felt it would be difficult for those with a background in mathematics only to teach the courses as they should be presented. Only two schools stated that their instructors of technical mathematics were mathematics majors. In fact, only two of the twelve schools employed mathematics majors as head of the mathematics department. The comments regarding instructors of technical mathematics are reproduced in full in Appendix C. Roney's conclusion was:

> Mathematics teachers in technical institutes were predominantly men with technical education and industrial experience. Teachers with this background were preferred because of their ability to relate mathematics instruction to the technical study.[20]

The danger that specialists would use too theoretical an approach and would be unsympathetic to the aims of technical education was a matter of great concern to Graney, who summarized:

> Theoretical study which is too advanced could make a teacher useless in an engineering technology classroom. His interests might not be with the problems of the technician; therefore he would be unfamiliar with and unsympathetic toward this level of challenge. Such lack of sympathy focuses attention upon an essential quality in a good technical institute faculty member. He must be convinced that this level of education has a real value of its own. If he thinks that a technical institute program is a watered-down version of engineering, he will fail in his mission. Unfortunately, such people have sometimes found their way into technical institute faculties. At times they undermine the confidence of students in their goals. That such an effect is achieved inadvertently does not lessen its deteriorating influence. Students can become dissatisfied with their program and thereby acquire a feeling of inferiority or of being secondary. They emerge as unhappy graduates, or perhaps abandon their education altogether.[21]

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[20]Maurice William Roney, op. cit., p. 134.

[21]Maurice R. Graney, op. cit., pp. 80-81.

Laws states that:

> Ability to cope with mathematical concepts alone is not enough to qualify a person to teach mathematics to technical students. Perhaps the best type of teacher is one who, in addition to his mathematical competence, has had practical industrial work experience . . . . The teacher of technical mathematics must be committed to the technician philosophy - preparing young men, including those with only average ability to cope with abstract ideas, to fill highly important positions with engineering teams in industry. This involves teaching courses that are designed to be utilitarian and highly practical in preparing the student for his vocation.[22]

The one source that was found which dissented from this majority opinion about the suitability of using mathematics majors to teach the technical mathematics courses was the study conducted by Miller. This dissertation was devoted to a comparison of two Illinois junior colleges, Triton College and College of DuPage. The two schools have different administrative structures. At Triton College, all curricula are administered by the dean of instruction except the technology curricula, which form a separate division with its own dean. DuPage, on the other hand, features a circular type of integration, with an effort made to have students take courses in many different departments in order to avoid isolation of any facet of the total program. Miller states:

> Since the principles embodied in these disciplines[mathematics and the physical sciences]are identical whether being applied to theoretical physics or to analysis of an electronic circuit, there is little justification for duplicating and fragmenting mathematics and the sciences for technology students. Circular integration is, in the opinion of this writer, wholly desirable and attainable in the comprehensive junior college.[23]

Miller does point out, however, that it is a good practice to have technical teachers teach science or mathematics to round out their load, thus avoiding the problems inherent in the use of part-time faculty.

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[22]Norman G. Laws, Mathematical Expectations of Technicians in Michigan Industries. (Dearborn, Michigan: Wayne State University, 1966), p. 21.

[23]Mark Eugene Miller, Issues Relating to the Establishment and Governance of a Technology Program in a Comprehensive Junior College (Doctoral dissertation: University of Illinois, 1967), p. 6.

While DuPage does offer its technical mathematics in the mathematics department, it should be noted that the courses taken by technology students are separate from those taken by all other curricula, which greatly weakens the integration it is intended to achieve.

The opinion of the experts in the field of technical education was well expressed at the 1968 Annual Meeting of the American Association for the Advancement of Science by Brodsky:

> Given a student body with adequate intellectual equipment - that is 'capable average' high school graduates, who do not get their 'kicks' from manipulating abstractions, who are not moved by the intrinsic beauty of mathematical structure, who are not committed to science for science's sake, who are earthy, pragmatic, and intellectually shallow at the time we meet them, but pressing to make a better life than their parents have - given this kind of student, we must take a hard look at all the positive and negative incentives in technical education which students perceive and respond to (positively and negatively). It is no surprise that a faculty composed of pure mathematicians is not especially successful in teaching mathematics to such students. Nor is it unexpected that a physics faculty with all of the conventional qualifications and disciplinary commitments fails to excite technology students.[24]

Eno, in his questionnaires, asked a number of questions about the qualifications to be sought in faculty for technology curricula. Most of these were related to the importance of industrial experience; the responses to these questions showed strongly that industrial experience is considered to be very important. One question asked for responses to the statement, "Technical teachers should be versatile enough to satisfactorily teach the basic science courses (e.g. mathematics, physics, chemistry) as well as the technical courses in their respective technologies." Eno's abstract of the comments on this question was

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[24]Stanley M. Brodsky, "Problem of Student Motivation and Identification with Science in Technical Education, "Science Education as It Relates to Technical Education. (Dallas, Texas: American Association for the Advancement of Science, 1968), p. 25.

as follows:

> Effectiveness in teaching the basic sciences at rigorous depths and broad coverage would probably be best accomplished by specialists in specific subject areas. This would be more true of physics than of mathematics and more true of chemistry than of physics.
>
> However, all technologies are based on the fundamentals of the sciences, and, therefore, the technical teachers, when feasible, should have the opportunity to do so at their request. Science subjects taught by such personnel would more intimately involve the students' motivating interests and perhaps accelerate his mastery of the material.[25]

Graphs of the responses to all of his questions concerning instructor qualifications are found in Appendix D.

The importance of industrial experience is stressed throughout the literature. The preference for instructors in the technology curricula who have industrial experience is universal. As early as 1931, the Wickenden-Spahr report stated that only four percent of the faculty members of technical institutes lacked industrial experience. In 1952, K. L. Holderman made a study of 533 full-time instructors at 18 institutes with ECPD accredited curricula. He found that the average industrial experience of the instructors was 5.5 years. Smith and Lipsett, in 1954, found that requirements in the technical institutes ranged from one to eight years of industrial experience.[26] Henninger found in 1959 that in 60 technical institutes responding to his survey, the average minimum industrial experience desired was five years, with teaching experience considered of secondary importance.[27] In the same year, Wood conducted

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[25] Richard S. Eno, Sr., op. cit., p. 51.

[26] John Greer, The Organization and Administration of Technical Education for Industrial Occupations with Emphasis on Teacher Education (Doctoral dissertation, University of Connecticut, 1967), p. 69.

[27] G. Ross Henninger, op. cit., p. 72.

a study for the state of California, and found that most administrators considered appropriate industrial experience an absolute necessity in the preparation of technical education instructors. His conclusion was:

> An academically trained instructor without employment experience in industry as a technician or in a closely related position would find it difficult to relate his knowledge to the industrial occupation for which his students would be preparing.[28]

A study by Emerson in 1963 supported this opinion:

> Its [technical institute] teachers are chosen principally on the basis of practical experience in technical occupations, applied technical ability, and personal qualities, rather than on scholarly preparation.[29]

Greer sent questionnaires to 778 institutions in all 50 states. He found that a minimum of 2.97 years of industrial experience in a specific, allied trade or occupation was required for state certification of technical institute faculty members in 68.6 per cent (35) of the states.[30]

A further comment on this subject was made by Miller, who stated:

> Vocational educators have long been aware that it is most difficult for a teacher to prepare students to function in industry if he is himself without industrial experience. Nevertheless, many technology programs are forced to operate with faculty having little or no industrial background, or with some type of provisional or stop-gap credential.[31]

It is the opinion of the experts that instructors of technical mathematics and technical physics should have acquired technical knowledge of greater depth and breadth than the courses they are likely to teach, and mathematical and

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[28]Herbert S. Wood, A Study of Technical Education in California (Sacramento: State Department of Education, 1959), p. 55.

[29]Lynn A. Emerson, Technical Training in the United States, OE-80022, Appendix I, Education for a Changing World of Work (Washington, D. C.: Department of Health, Education and Welfare, 1963), p. 60.

[30]John Greer, op. cit., pp. 69-70.

[31]Mark Eugene Miller, op. cit., p. 82.

scientific knowledge appropriate to the technology, level, and emphasis with which the courses will be taught. Such a requirement has been included in guidelines for technical teacher education programs.[32]

III. CONCLUSIONS

A study of the literature led to the following conclusions:

1. Technical mathematics for technology curricula should be taught in separate courses from the mathematics offered for other curricula.

2. Topics selected for inclusion in the technical mathematics courses should be those necessary in the technical specialties.

3. There should be strict avoidance of too theoretical an approach in teaching technical mathematics. The courses should be kept on an applied level, with many illustrations from industry.

4. Careful coordination of the mathematics and the technical specialties is necessary.

5. Technical physics courses require the same care in selection of topics, avoidance of too much theory, and coordination with the technical specialties as is needed in the mathematics courses.

6. Experts in the field of technical education feel that instructors for technology curricula, including the basic sciences, should be engineering or science majors. Those with a background in mathematics only are considered to be too theoretical in their approach to be useful as instructors of technology courses.

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[32] A Summer Institute for the Improvement of Technical Teacher Education Programs, Final Report of Project 7-0528, U. S. Office of Health, Education and Welfare, November, 1967, p. 2.

7. A thorough understanding of and sympathy for technology programs should be a prerequisite for teaching courses in technology curricula, including the related sciences.

8. Industrial experience in a related occupation is considered to be a prerequisite for teaching in technology curricula.

9. Teachers in technology programs should have knowledge of their subjects of greater depth and breadth than they are required to teach.

CHAPTER III

PRELIMINARY SURVEY OF ILLINOIS JUNIOR COLLEGES

Junior college education in Illinois has undergone tremendous growth since the passage of enabling legislation in 1965. Many new schools have opened, and existing institutions have modified their programs in order to qualify as Class I junior colleges. The Illinois Public Junior College Act, one of the finest such pieces of legislation in the country, has helped Illinois to attain a position of leadership in junior college education.

Even so, the quality of junior college education throughout the state is not uniform. In the area of technical education, the sole concern of this study, the quality to be found in junior colleges in the state ranges from outstanding to poor.

Since its opening three years ago, Illinois Central College has been acknowledged to be one of the top-ranking junior colleges in the state in its technology programs. This study therefore examines the practices regarding technical mathematics and technical physics courses in Illinois junior colleges with technology programs of comparable quality to that at Illinois Central College. Twelve junior colleges in Illinois offering high quality technology programs were identified, as discussed earlier. Practices in these schools were compared with general practice throughout the state.

A questionnaire was designed to explore present practices in the teaching of technical mathematics and technical physics in the junior colleges. The questionnaire inquired whether technical mathematics and technical physics are offered, and if so, in what department; whether

industrial experience is sought in hiring instructors for these courses; whether the school would be willing to participate in later phases of this study; and whether the school would like to receive a summary of the study. A copy of the questionnaire and the covering letter can be found in Appendix E.

The questionnaire was sent to the Dean of Instruction of 36 Illinois junior colleges; the Vocational-Technical Institute of Southern Illinois University was included among those receiving the questionnaire, since it functions as a separate division of a school offering four-year curricula, and was among those schools identified as outstanding.

The questionnaire was returned by 29 schools in time to be included in this report. Of the 12 schools named by the experts who were consulted, 8 responded in time to be included. These were: (1) Belleville Area College, (2) Black Hawk College, (3) Highland Community College, (4) Illinois Central College, (5) Lakeland College, (6) Thornton Community College, (7) Triton College, and (8) Vocational-Technieal Institute of Southern Illinois University. The answers of these 8 schools have been tabulated, and compared with the answers of all other junior colleges which have responded.

In tabulating the results, the most striking fact to emerge was that throughout the state, only one junior college fails to offer technical mathematics, and only four do not offer technical physics. Among the 8 leading schools selected for study, there are no schools which do not offer technical mathematics, and only one which does not offer technical physics. It appears that there is state-wide recognition of the need for specialization of the basic science courses for technology programs which is so strongly recommended in the literature.

When the departments offering the technical mathematics and technical physics courses are examined, a sharp contrast is obvious between the schools selected by the experts and the other responding schools. Of the 8 schools identified as outstanding, 7 offer technical mathematics in the technology department, and only 1 offers these courses in the mathematics department. In the other 21 schools participating in the study, on the other hand, technical mathematics is offered in the technology department in only 6, 13 schools offer these courses in the mathematics department, 1 has no departmental structure, and 1 does not offer such courses. Of the 6 schools in this group which offer technical mathematics in the technology department, 3 also have some technical mathematics courses in the mathematics department.

The same contrast in practices is apparent in the technical physics courses. Of the 8 selected schools, 5 offer technical physics in the technology department, 1 in the science department, and 1 does not offer such courses. The remaining school in this group offers technical physics, but did not specify in which department it is offered. In contrast, among the other schools in the state, only 2 offer technical physics in the technology department, 15 offer these courses in the science department, 3 doe not offer specialized technical physics courses, and again 1 school has no department organization.

Among the schools identified as leaders in technical education in Illinois, the prevailing practice is clearly to offer the technical mathematics and technical physics courses in the technology department, while among those who were not so identified, the trend is to offer these courses in the academic departments.

In response to the question, "Is industrial experience sought in hiring instructros to teach technical mathematics?" 6 of the 8 selected schools

answered yes, 1 indicated that such experience is desirable but not necessarily mandatory, and 1 answered no. Of the 20 other schools offering technical mathematics, 10 seek industrial experience in hiring instructors, 4 consider such experience desirable but not necessarily mandatory, and 6 do not seek such experience.

The practice is very much the same in hiring instructors for technical physics. Of the 7 schools with outstanding technology programs which offer technical physics, 4 seek industrial experience and 2 do not; 1 school did not respond to this question. Of the 18 other schools which offer technical physics, 9 seek instructors with industrial experience, 4 consider it desirable if possible, 1 did not respond to this question, and 4 do not seek such experience.

It appears that throughout the state, instructors with industrial experience are preferred by the majority of schools; however, the schools identified as having outstanding technology programs place more importance on this factor than the other schools which responded.

The departmental distribution of the technical mathematics and technical physics courses in the schools identified as outstanding in technical education is given in Table 1; the same information for other schools in the state appears in Table 2. Figures 1 and 2 give a complete breakdown of the answers to the questionnaire for the two groups of schools.

Response to the questionnaires was gratifying. Of the 29 participating schools, 20 indicated willingness to cooperate in later phases of the study, 2 gave qualified answers, 4 did not respond to this question, and 3 did not care to participate. A summary of the study was requested by 23 schools, 4 did not respond to this question, and 2 did not care to receive a summary.

Table 1. Departments Offering Technical Mathematics and Technical Physics in Schools Selected for Study

School Name	Technical Mathematics		Technical Physics		
	Technology Dept.	Math Dept.	Technology Dept.	Science Dept.	None
Belleville Area College	X		X		
Black Hawk College	X				X
Highland Community College	X				
Illinois Central College	X		X		
Lake Land College	X		X		
Thornton Community College		X		X	
Triton College	X		X		
Vocational-Technical Institute of Southern Illinois University	X		X		

Table 2. Departments Offering Technical Mathematics and Technical Physics in Other Junior Colleges in Illinois

School Name	Technical Mathematics			Technical Physics			No. Dept. Organ.
	Tech. Dept.	Math Dept.	None	Tech. Dept.	Sci. Dept.	None	
Carl Sandburg College	X	X			X		
Chicago City Colleges	X	X			X		
College of DuPage		X			X		
College of Lake County		X			X		
John A. Logan College			X			X	
Illinois Valley Community College		X			X		
Kankakee Community College		X			X		
Kaskaskia College		X			X		
Kishwaukee College		X			X		
Joliet Junior College		X			X		
Lincoln Land Community College		X			X		
McHenry County College	X			X			
Moraine Valley Community College							X
Morton Junior College		X				X	
Olney Central College	X	X			X		
Prairie State College		X			X		
Sauk Valley College	X				X		
Shawnee Community College	X					X	
Southeastern Illinois College		X			X		
Spoon River College		X			X		
Wabash Valley College		X		X			

Figure 1. Answers to Preliminary Questionnaire
Schools Selected for Study

1. Does your school offer technical or applied math for engineering and industrial technology students?

yes 8 no 0

2. If such courses are offered, in what department are they taught?

Technology 7 Mathematics 1

3. Does your school offer technical or applied physics for engineering and industrial technology students?

yes 7 no 1

4. If offered, in what department are they taught?

Technology 5 Science 1 No answer 1

5. Is industrial experience sought in hiring instructors to teach technical math?

yes 6 desirable, not mandatory 1 no 1

technical physics?

yes 4 no [illegible] no answer 1

6. Are you willing to participate in later phases of this study

a) by distributing questionnaires to students in selected classes in engineering and industrial technology and in transfer curricula?
yes 4 no 2 no answer 2

b) by distributing questionnaires to instructors in math, science, and engineering and industrial technology departments?

yes 5 no 1 no answer 2

7. Would you like to receive a summary of this study?

yes 7 no 0 no answer 1

Figure 2. Answers to Preliminary Questionnaire; Other Schools in Illinois

1. Does your school offer technical or applied math for engineering and industrial technology students?

   yes 20 no 1

2. If such courses are offered, in what department are they taught?

   Technology 3 Mathematics 13 Both 3 No Dept. Organ. 1

3. Does your school offer technical or applied physics for engineering and industrial technology students?

   yes 18 no 3

4. If offered, in what department are they taught?

   Technology 2 Science 15 No Dept. Organ. 1

5. Is industrial experience sought in hiring instructors to teach technical math?

   yes 10 desirable, not mandatory 4 no 6 no answer 1

   Is industrial experience sought in hiring instructors to teach technical physics ?

   yes 9 desirable, not mandatory 4 no 4 no answer 4

6. Are you willing to participate in later phases of this study

   a) by distributing questionnaires to students in selected classes in engineering and industrial technology and in transfer curricula?

      yes 9 sample size less than 50 3 qualified answer 2
      no answer 4 no 3

   b) by distributing questionnaires to instructors in math, science, and engineering and industrial technology departments?

      yes 15 qualified answer 2 no answer 2 no 2

7. Would you like to receive a summary of this study?

   yes 16 no 2 no answer 3

CHAPTER IV

TECHNICAL MATHEMATICS AND TECHNICAL PHYSICS COURSES AT ILLINOIS CENTRAL COLLEGE

The various mathematics and physics courses in the Engineering and Industrial Occupations Division and in the Mathematics and Science Division at Illinois Central College have been examined in order to determine whether there are at present courses in the Mathematics and Science Division which parallel, and could take the place of or be combined with, the technical mathematics and technical physics courses. The various advantages and disadvantages of teaching the technical mathematics and technical physics in the Mathematics and Science Division have also been weighed.

I. COURSES PRESENTLY BEING OFFERED

Gentk 101 offers fundamental arithmetic concepts for the student who is deficient in this area. The Mathematics and Science Division is offering a new course, Math 104, which appears to cover the same material. The two courses use different textbooks; the main difference between the two texts is that the book used for Gentk 101 includes a section of practical applications to everyday problems not included in the text for Math 104.

Gentk 102, an algebra course for the student who did not take algebra in high school or who needs a review at that level, appears to parallel Math 106 quite closely. Both are five credit hour courses, they cover the same material and use the same textbook. The main difference between the two courses is the pace at which they are taught. Instructors teaching Gentk 102 teach the first portion of the course, the basic algebraic concepts on which the student must later build, more slowly than those teaching Math 106.

The later portions of the course are then taught at a faster rate in Gentk 102, so that by the end of the semester, the same material has been covered.

Small sections of Gentk 102 and Math 106 were successfully combined this summer. Students from both divisions seemed to find the arrangement satisfactory. However, the combined sections were taught from the Gentk 102 syllabus by one of the technology instructors; it is therefore not possible to say at this time whether the technology students could adjust satisfactorily to the pace of Math 106.

It appears that from the standpoint of course content alone, it might be possible to combine sections of Gentk 101 with Math 104, and Gentk 102 with Math 106, either in the Mathematics and Science Division or in the Engineering and Industrial Occupations Division. Care would need to be taken that the courses were taught with many practical applications, and in the case of the algebra course, the pace would need to be controlled so that all students received firm grounding in the basic concepts.

However, there are factors to be considered other than course content. The technology students develop a very close relationship with the instructors in the Engineering and Industrial Occupations Division, and feel very free to come to them for help. If the instructor teaching a particular course is not free to help them, they do not hesitate to ask for help from another member of the staff. This "family" atmosphere is extremely beneficial in the basic science courses, which lay the foundation for the technical specialties. It is at least as important in courses designed for students who enter with deficiencies as for those who enter with all necessary prerequisities. If these students are unsuccessful in their remedial work, or if they are made to feel that the aims of technology programs are unworthy, they may be lost to higher education forever.

Gentk 103 is a geometry course for students who did not take, or who need to review, high school level geometry. The same text is used in Gentk 103 and Math 107. However, Gentk 103 is a three credit hour course and Math 107 is a five credit hour course. Math 107 covers the entire textbook. Gentk 103 does not cover the chapters on set theory, inequalities, coordinate geometry, and geometric loci because those designing the curricula felt that this material was not necessary for technology programs.

Combining these two courses would mean that the technology students would either have to cover more material than has been deemed necessary for them, and take an additional two credit hours of geometry, or they would have to attend the five-hour course until the material covered in Gentk 103 has been completed, and not attend the final weeks of the semester. The chapters on set theory and inequalities occur before other material which is included in Gentk 103, so that either rearrangement of the material or a lapse in attendance time would be necessary if this plan were followed.

The first suggestion is the choice of the Mathematics and Science Division; however, it is not in accord with the opinions of experts in the field, who have stated in the literature that topics for technology students should be carefully selected and because of the limitations of time, should be restricted to just those topics necessary. The second solution would mean that the technology students would have to learn geometry at a more accelerated pace than they do at present. It appears unwise to provide any further obstacles for students who are already entering with a deficiency.

Gentk 104 is pre-technical physics course for the student who has not had a year of high school physics. There is no comparable course in the Mathematics and Science Division.

Gentk 107 offers the practical application of geometry and trigonometry. There is no comparable course in the Mathematics and Science Division.

Gentk 135, 136, 137, and 138 are the technical mathematics courses. They present carefully selected topics from algebra, trigonometry, analytic geometry, and the calculus. Gentk 135 carries the student through the rudiments of analytic geometry, Gentk 137 proceeds just to a bare introduction to the calculus, Gentk 136 is designed for those students who need elements of the calculus. Gentk 138 is for the student who has taken Gentk 137 and finds that he needs the calculus which is included in Gentk 136. These courses have been designed in accordance with the recommendations of experts in technology curricula. The topics have been carefully arranged in order to coordinate with the technical specialties.

There are no comparable courses in the Mathematics and Science Division. This division has suggested that Gentk 135 should be eliminated, and technology students should instead take separate courses in algebra, trigonometry, and analytic geometry. The rationale for this is that the students do not receive a complete course in any of these subjects. Their credits, while transferable to almost all four-year technology programs, would not be transferable should the student decide to transfer to a four-year engineering program. The technology curricula, however, are not designed to be transferable into engineering programs, and it would be in contradiction to the basic philosophy of technical education to try to make them so. A disservice would be done to the majority of the technology students if, for the sake of the small percentage who might decide to transfer to engineering, all technology students were required to take a minimum of three credit hours of algebra, three hours of trigonometry, and five hours of analytic geometry, a total of eleven credit hours, instead of the five credit hours now required by Gentk 135. It would not be possible to start

many of the technical specialties until at least the third semester of the two-year curricula.

These courses could not be combined with any existing courses without doing great damage to the technology curricula.

Gentk 112 and 113 are the two technical physics courses, offering non-calculus based coverage of the same basic physical concepts covered in Phys 120 and 121. The approaches are not the same in the two series of courses, however. In addition, Phys 120 and 121 are each five credit hour courses, while Gentk 112 and 113 are each four credit hour courses.

Apparently when the courses were first offered, they were more similar than they now are. At that time, both divisions used the textbook, Fundamentals of Physics by Semat. However, the Engineering and Industrial Occupations Division found this book too theoretical, and changed to Physics for Engineering Technology by Joseph, Pomeranz, Prince and Sacher, which places more emphasis on practical applications. The Mathematics and Science Division has also changed textbooks, and now uses The New College Physics by Baez. The arrangement of topics in this textbook would not be satisfactory for the technology curricula. In addition, the presentation is at a higher level of theory. It appears, therefore, that the two courses have become increasingly divergent, and could not be combined without detriment to the technology curricula.

II. ADVANTAGES AND DISADVANTACES OF TEACHING TECHNICAL MATHEMATICS AND TECHNICAL PHYSICS IN THE MATHEMATICS AND SCIENCE DIVISION

A number of reasons have been suggested for placing the technical mathematics and technical physics courses in the Mathematics and Science Division. A discussion of these reasons follows.

Economy. If courses from the two departments can be combined, an economy can be effected whenever sections are small. However, if the technical mathematics and technical physics courses must still be offered, it is no more economical to offer them in one department than in the other.

Jerry S. Dobrovolny, Past President of the American Technical Education Association, has stated, in a personal interview, that occupational programs are always expensive, that specialized technical mathematics and technical physics courses are necessary for a high quality technology program, and that unless a school is willing to spend the money necessary for a high quality program, it should not offer technical education at all.

Transferability. The Mathematics and Science Division has suggested changing the technical mathematics courses in order to make them transferable to engineering programs. However, the literature speaks strongly about the importance of designing technology curricula not to be like transfer curricula, but to serve the students who plan to earn their Associate Degree and enter the work force immediately. This is the aim of technical education, and not to try to prepare students to continue on to the baccalaureate degree.

Level of Theory. Since the instructors who teach mathematics and physics in the Mathematics and Science Division are specialists in these areas, they are better prepared to teach these subjects at a highly theoretical and rigorous level than the instructors in the Engineering and Industrial Occupations Division. However, another point strongly made throughout the literature is that a highly theoretical approach is detrimental to the technology student, and that instructors who favor such an approach do not make effective teachers in technology programs. Instructors with industrial experience and a strong leaning toward practical applications are favored by the experts in technical education. The suggestion of the Mathematics and

Science Division that the level of theory in the technical mathematics and technical physics courses should be raised would seem to be in direct opposition to the recommendations of the experts in the field.

Better Integration of the Students into the Student Body. It is not desirable that the technology students should feel isolated from the other students on campus. Every effort should be made to achieve an integrated student body. The suggestion has been made that teaching technical mathematics and technical physics in the Mathematics and Science Division would aid this integration. This would not be true, however, if the technology students do not attend the same classes as the other students. If special courses are needed for the technology students, the integration value of having them in another division seems small.

It has been suggested that scheduling the technical mathematics and technical physics courses in the same building as the other mathematics and physics courses, even if taught by technology instructors, would help the students to mingle between classes. This should be easy to arrange, since classes are already scheduled in a variety of buildings. The overall responsibility for the courses should, however, rest with the division which teaches them.

A study of the catalog shows that at Illinois Central College, as at most junior colleges, approximately twenty-five per cent of the course work in the technology curricula is in social science, communications, and the humanities. This should be helpful in integrating the technology students into the student body.

Curriculum Coordination is very important in technology programs, where time is limited and topics must be carefully selected and arranged. The

dependence of the technical specialties on the basic sciences makes coordination in this area particularly vital. Several rearrangements have been made in the three years that Illinois Central College has been in operation. Such adjustments can be made more easily when the courses are in the same department and instructors are in daily communication. Moving the technical mathematics and technical physics courses to the Mathematics and Science Division would not make coordination impossible, but it would make it more difficult and less automatic.

Prevailing Practice. In the Illinois junior colleges which were identified as having outstanding technology programs, the prevailing practice is to offer the technical mathematics and technical physics courses in the technology departments. This is in sharp contrast to the practice in the other schools in the state; in these schools, the prevailing practice is to offer these courses in the academic departments.

It has already been noted that the literature particularly stresses that the faculty for technology programs should be completely involved in the technical education philosophy and should have a practical background and outlook. It appears that the selected schools recognize this need.

Variety of Course Assignments for Instructors. The Mathematics and Science Division is very pleased to be able to offer variety in the teaching assignments for instructors. This undoubtedly helps the faculty to remain alert and motivated. The same practice is followed in the Engineering and Industrial Occupations Division.

Preference of Courses Taught. The second phase of this study investigated faculty preferences in teaching various courses. It was found that

preferences of faculty members in mathematics departments are very different from those of faculty in the technology departments. These results have been discussed in the second portion of this report.

Industrial Experience of Instructors. If the criteria set forth in the literature are to be considered in placing the basic science courses for the technology programs, the industrial experience of instructors in the two divisions should be taken into account. This has also been investigated and discussed in the second phase of this study.

Ability to Teach the Courses Satisfactorily. The Mathematics and Science Division has stated the conviction that their instructors could teach the technical mathematics and technical physics in a manner satisfactory to the Engineering and Industrial Occupations Division. The same is also true of the instructors hired by the Engineering and Industrial Occupations Division.

Understanding of and Sympathy toward Technology Programs. This factor has already been mentioned in discussing other topics. It cannot be stressed too strongly, since in the eyes of the experts, these qualities should underlie all others in the selection of faculty members for technology programs, not only for the technical specialties, but for the basic sciences as well. The attitudes of the instructors in the two divisions have been evaluated in the second phase of this study.

CHAPTER V

SUMMARY

A review of the literature has revealed great unanimity of opinion among the experts in technical education conerning the need for specialized courses in mathematics and physics for technology programs. Such courses should consist of carefully selected topics, depending on the particular needs of the curricula offered. Coordination with the technical specialties is essential. An applied approach should be used, with avoidance of too deep a level of theory. General college mathematics and physics courses, or those designed for transfer curricula, are inefficient for technology curricula, and therefore inappropriate.

There is also unanimity of opinion concerning the desirable characteristics of instructors for the technical mathematics and technical physics courses. The experts agree that all instructors in technology curricula should understand and be in sympathy with the philosophy of technical education. Industrial experience is regarded as extremely important. Specialists in mathematics or physics who have theoretical training only may be ineffective instructors in technology programs; instructors with degrees in engineering or science and with industrial experience, as well as empathy for the pragmatic students in such curricula, are preferred. Instructors should have acquired technical knowledge of greater depth and breadth than the courses they are likely to teach.

A survey of the junior colleges in Illinois revealed that all but one school offers technical mathematics, and all but four offer technical physics. In the schools identified as outstanding in technical education, the prevailing practice is to offer technical mathematics and technical physics in the technology departments. In the other schools in the state, the prevailing practice is to offer these courses in the academic departments. The majority of junior colleges in Illinois seek instructors with industrial experience to teach technical mathematics and technical physics courses; this trend is, however, stronger in the schools identified as outstanding than in the other Illinois junior colleges.

At Illinois Central College, only two of the technical mathematics courses and none of the technical physics courses are parallel in course content to courses being offered in the Mathematics and Science Division. In these two courses, which are pre-technical courses for students entering with deficiencies, there are differences in the method of teaching. In addition, psychological factors relating to the philosophy of the instructors are important in all courses in technology programs; the McGraw Report especially stresses the importance of attention to these factors in the mathematics and physics courses. Students who enter with deficiencies require at least as much psychological support as those who have all the prerequisites, if not more.

When the Division Chairman of the Mathematics and Science Division was interviewed, he suggested several changes to be made if the technical mathematics and technical physics were taught in that division. These were:

(1) Gentk 102 should be combined with Math 106

(2) Gentk 103 should be combined with Math 107; technology students would then take five credit hours of geometry instead of three credit hours as they now do, in order that they should learn all of the topics covered in the textbook being used.

(3) Gentk 135 should be discontinued since the credit for this course is not transferrable to four-year engineering curricula, and technology students should take instead algebra, trigonometry and analytic geometry in separate courses.

(4) Gentk 112 and 113 should be combined with the more theoretical Phys 120 and 121.

(5) The level of theory should be reased in all the technical mathematics and technical physics courses.

(6) Technical mathematics should be taught by instructors with masters degrees in mathematics; a masters degree in physics should be required for those teaching technical physics.

With one possible exception, the faculty members presently teaching those courses would not be considered capable of teaching them in the Mathematics and Science Division.

These suggestions are in contradiction to the recommendations of all the experts in technical education. If they were implemented, the basic science courses for the technologies would be changed in ways which would be detrimental to the entire technology program.

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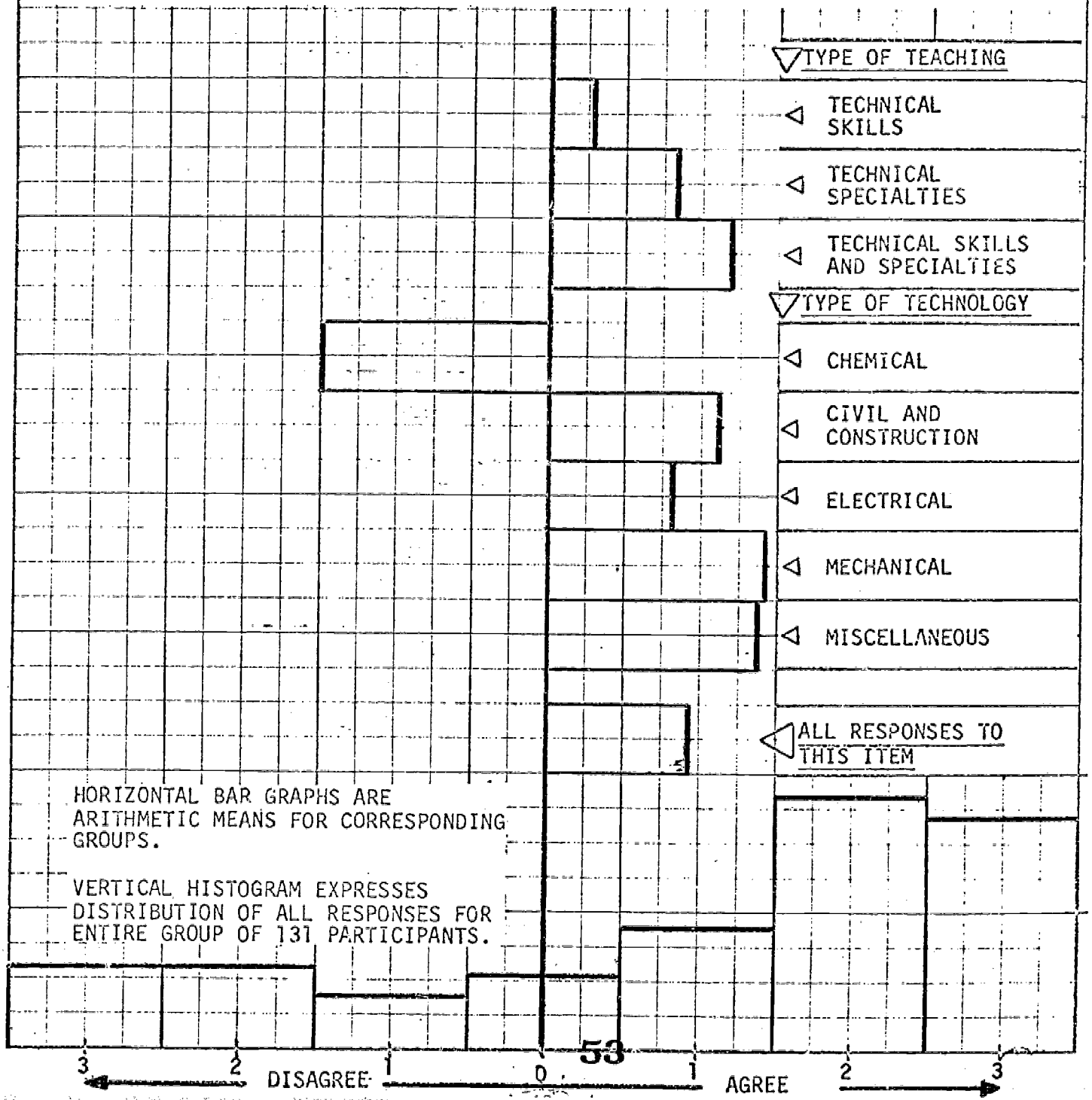
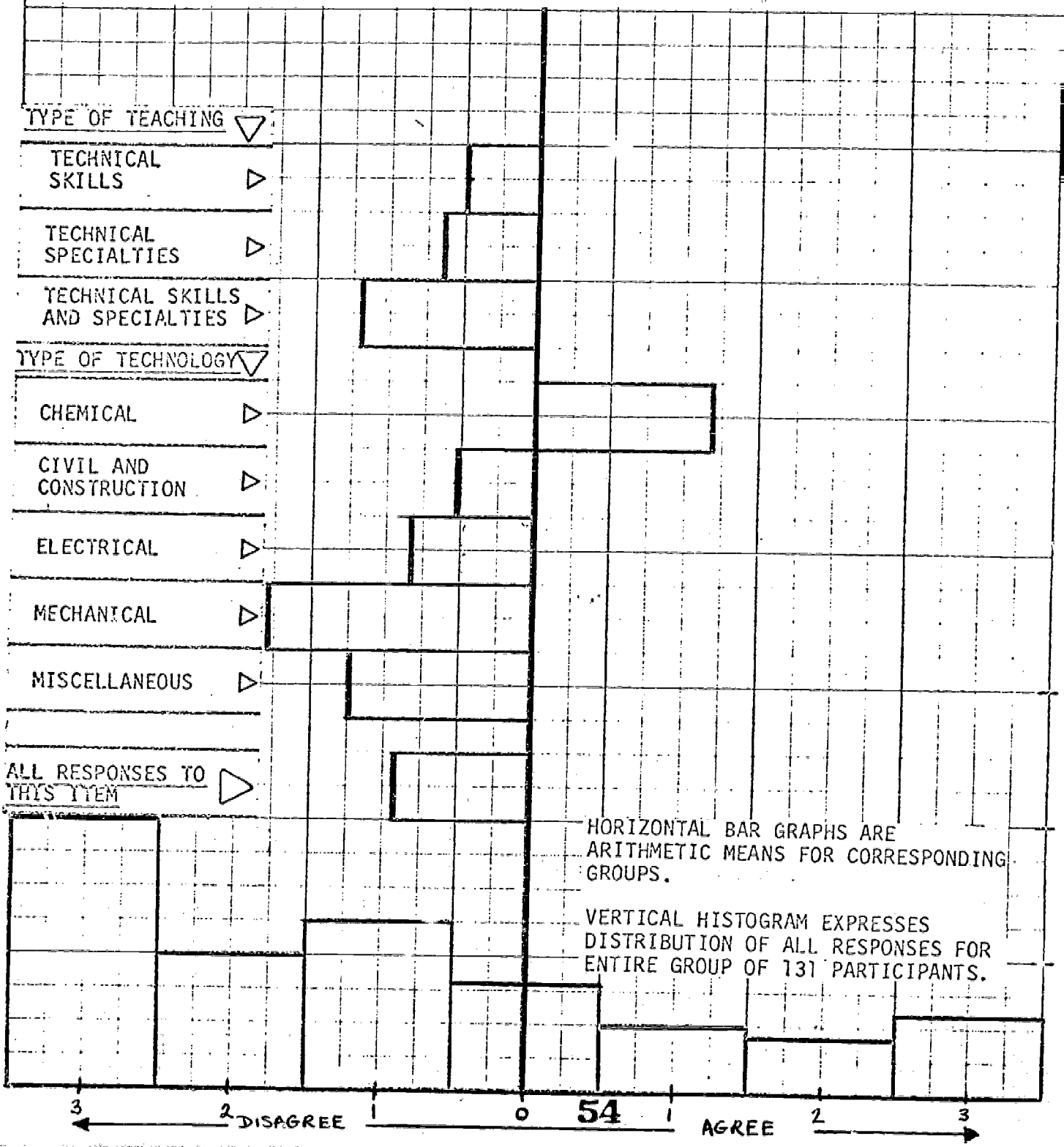
APPENDIX A

GRAPHS OF ANSWERS TO QUESTIONS CONCERNING METHODS OF TEACHING BASIC SCIENCES IN TECHNOLOGY CURRICULA

IV-16 BASIC SCIENCE COURSES IN ENGINEERING TECHNOLOGY PROGRAMS (E.G. MATHEMATICS, PHYSICS, CHEMISTRY) SHOULD BE TAUGHT AS RELATED SUBJECTS RATHER THAN AS "PURE" SUBJECTS.



IV-8 THE BASIC SCIENCES (E.G. MATHEMATICS, PHYSICS, CHEMISTRY, ETC.) SHOULD BE TAUGHT AS PURE SCIENCES.



APPENDIX B

ANSWERS TO INTERVIEW QUESTIONS CONCERNING

METHODS OF TEACHING TECHNICAL MATHEMATICS

IN TECHNOLOGY CURRICULA

INTERVIEW NOTES

In 1962 and 1963, Roney conducted interviews at twelve selected schools participating in his study. All interviews were tape recorded to insure accuracy of reporting. Answers to the following questions are here reproduced in full:

1. Are the mathematics in these [technology] curricula specialized to meet the requirements of technical curriculum or are they general in nature?

2. To what extent are applications used in the teaching of mathematics?

3. Is the emphasis in mathematics on the derivation of equations or on their use in the solution of problems?

School A

TYPE: State College

STATEMENT: Head, Technical Institue Mathematics and Physics Department

The criteria used for determining the mathematics course content are the mathematics concepts and abilities needed in the technical course work in the technical institute. Topics included in the mathematics courses are essentially the same as would be found in engineering courses. This includes the topics required for an introduction to calculus. The sequence of topics would not be the same in all cases as in a more complete engineering course.

Instruction stresses the application of mathematics in the solution of practical problems. These applications are chiefly in mechanical and electrical fields. We have reduced the amount of formula derivation to a

minimum and have gone primarily to the use of formulae. Students are not required to derive equations although they are expected to understand derivations.

School B

TYPE: Community College

STATEMENT: Head, Mathematics Department

All students except those enrolled in electrical and electronic technologies take a common course. This course is applied mathematics with problems selected from several curriculum areas. No attempt is made to concentrate the applications in any one curriculum field.

Electrical and Electronics curricula include a three-credit course in applied mathematics with the applications largely confined to the field of electricity.

By reason of the specialized design of these mathematics courses they do not prepare the student for advanced mathematics courses.

The three-credit applied mathematics courses in the first semester of each curriculum are intended to develop the student's ability to apply algebra and trigonometry in the solution of problems. They are not intended to teach mathematical forms beyond the fundamentals of algebra and trigonometry.

Approximately seventy-five per cent of the students who enter the technology programs take the pre-technology mathematics course offered by the technology department. This is a three-credit composite algebra

and trigonometry course offered for those who have not taken advanced algegra and trigonometry in the high school.

In the electronics curriculum the applications used in the mathematics course are primarily electrical in nature. The course required for the other technologies includes applied problems in mechanics, electricity, heat, power, engineering economics and the use of the slide rule.

School C

TYPE: Private Technical Institute

STATEMENT: Head, Mathematics Department

All of the mathematics taught in the technology curricula is selected material. Basic preparation in mathematics through trigonometry is prerequisite for admission to the curriculum. This permits a concentration on mathematics applications, wherever they are needed in technical courses. Teachers of technical courses review the mathematics forms that are needed as new applications are introduced.

Demands of technical education in design preclude "soft" curriculum in mathematics. For example, just considering the electronics curriculum, apart from algebra which is used constantly, the most important operations worked with, during the first semester, are probably, the J operator, complex numbers, and their graphical representations.

Trigonometry also has a wide application in electronics and is used extensively in the solution of alternating current problems.

A working knowledge of logarithims [sic.] is essential for tackling such problems as power gain, or the gain or an amplifying circuit, which may be given in decibels. Another system of logarithims [sic.] often used is the Natural System, sometimes called the Napierian System. The Natural System, using the base e instead of the base 10, will be seen many times in the solution of transient circuits.

Exponential equations also get their fair share of treatment in vacuum tube emission-efficiency problems. Exponential equations may or may not be met during the first semester, depending upon the particular curriculum.

Simultaneous equations will have to be dealt with when the electronic student begins his study of Kirchhoff's Laws, and Thevenin's Theorem.

The use of the slide rule is mandatory. In addition to the basic multiplication and division scales, it is advantageous to be familiar with the logarithmic and trigonometric scales.

The usefulness of scientific notation to expedite the solving of involved calculations is well known. A combination of the slide rule and scientific notation is a powerful method of dealing with the large and small numbers encountered in electronics.

All of the above mentioned mathematics will, in all probability, be used during the first semester.

School D

TYPE: Community-Technical Institute

STATEMENT: Dean of Instruction and Head of Mathematics Department

The mathematics program is in a period of transition. At the start of this school year all specialization of mathematics in the first two courses

was discontinued. Students from all technologies were sectioned together where formerly they had been grouped in mathematics courses by technologies.

The criteria for determining mathematics course content is established on the basis of decisions made by a curriculum committee. The primary criterion is the mathematics needed for the technical courses.

The conversion of mathematics from specialized courses to general courses has created problems. With the present system, no attempt is made in the first term to relate the instruction in mathematics to the specific requirements of each technology. Actually some technical applications are used in the teaching.

An attempt has been made to provide both the mathematics needed for higher mathematics and the mathematics needed in the technology programs. We may have moved too fast into higher mathematics. Until this year we sectioned students in mathematics courses by technologies and used selected applications. This year we put all of our mathematics together in one course. It simply hasn't worked. We have had a forty per cent failure rate.

From the standpoint of motivation of student it is probably better to specialize the mathematics by curriculum.

We spend little time in such things as fundamental identities in trigonometry. There isn't time for this in the two-year program. The time spent on derivation of equations must also be limited, to make it possible to cover more topics.

School E

TYPE: Private Technical Institute
Endowed, Non-profit

STATEMENT: Dean of Instruction and Head, Mathematics Department

The general objective of this instruction is to provide the tools necessary for technical study. It is not taught as a mathematician would need it.

We cover the same topics as in a four-year college program but not to the same depth.

Electrical students do not cover moment of inertia and centroids--the civil and mechanical students do.

Applications are used but not to the extent that the application becomes an end in itself. One of the problems here is that the application may be so involved that the student loses sight of the mathematics concepts. Also the instructor may not be competent to teach the applications. We try to use applications that are basic--those which the student knows something about.

We do not cover series. However, we expect to add this also in the near future. We do not require the student to do many derivations. We present them. We would require the complete derivation of the theory of limits and the basic obtaining of derivatives by means of the theory of limits and the increment method.

Slide rule work is taught in the first two weeks of the first term but unless the instructors insist on the use of the rule, this is of little value.

In differential calculus we don't need to be concerned with exponential functions. We can make use of the integral calculus without using all of the trick manipulations necessary for derivation. In our statics we don't need

calculus but in the dynamics (second semester) we need both differential and integral calculus. At that time we will show them the formula for an integration and go ahead and use it.

We are thinking of using a new mechanics book next year. This will require more emphasis on vector algebra in the mathematics courses.

School F

TYPE: Community College

STATEMENT: Head of Mathematics Department

Mathematics courses are designed to cover the mathematics needed in technical courses. For our new program that starts in 1963 we will also indicate the mathematics needed for an introduction to calculus.

We do not include the following topics which would probably be covered in a pre-engineering mathematics program: theory of equations, infinite series, and permutations and combinations. In trigonometry, identities are not covered in depth.

The primary purpose of technical course work is to teach the student to apply principles.

My view is that derivations have their place. The student has a legitimate right to ask "Where does the equation come from?" This should be anticipated by the instructor in many cases. He should know where it is logical to show the development of an equation within their framework of understanding. This can be done without the use of calculus in most cases.

At some point it will always be necessary to make some assumptions. It is not the mechanical procedure of derivations that is important in technical study. For the most part, formulas are derived under certain very

strict assumptions and therein lies the importance of derivations. If the student knows what these assumptions are--and their limitations--he will be able to use the formula sensibly.

The important aspect of formulae is that they are mathematical models. No derivation should be given by the instructor in which the element of the derivations are not understood. It is not always necessary that the student be able to do the derivation himself.

It is the use of the formula in its final form that is important to the student, not the intricate steps in the derivation, which includes a thorough understanding of the scientific assumptions that are a part of the development of a formula.

An example in the study of thermodynamics is the P. V. T. relationship in an isothermal process dealing with the work done. The students will have some idea of approximating the results to be obtained. This can be done without the use of calculus in most cases, if the student starts with some knowledge of pressures, volumes and temperatures as they apply to the model of a perfect gas. In making a summation of the work done by all of these variables a simplified approach using a Σ and $\triangle$ notation can be used to lead into an integral form of a differential function. At this point the student must be advised that a complete understanding of the integrative process can be obtained only by a knowledge of the calculus.

School G

TYPE: Technical Institute

STATEMENT: Head of Mathematics Department

We teach a traditional sequence of mathematics with little specialization. The text that is used does bring in applications and we try to pull practical

problems from the technology teachers.

The topics covered in mathematics courses are about the same as those in any college mathematics course. Some that are omitted in the technical courses are higher order equations and infinite series. The sequence of topics follows the textbook.

We find that the student has very little need for derivations. We do not have time to go through long derivations. The student should be able to follow a derivation; that is he should understand the steps in a derivation. Perhaps he will not have mastered all of the procedures of mathematics necessary for the derivations.

School H

TYPE: State Land Grant University
Technical Institute Division

STATEMENT: Head of Technical Institute Mathematics Department

All of the mathematics courses are taught by the institute staff. The mathematics courses are designed especially for technical study. The criteria for the content is based entirely on the specific mathematics needed in technical courses.

In the electronics curriculum the mathematics is tailored for the requirements of electronics study. Emphasis is given to vector algebra and special forms of differential and integral calculus.

Another mathematics sequence is taught for all other engineering technology curricula. In this sequence the applications are more general and are taken from several fields of technology.

No attempt is made to cover all of the mathematics needed for a study of higher mathematics.

The mathematics needs of each curriculum are unique in some respects. In electrical and electronics technology curricula we completely tailor the mathematics. In all other curricula the mathematics is more general. We do, however, emphasize functional mathematics. The ability to solve practical problems is more useful to the technical student than facility with pure mathematics.

From the standpoint of the technical student he has a need for identities and other basic laws only as a tool in learning. He should understand their use but he may not need to be able to prove them, just be able to follow their proof and understand. Practice with identities is needed, however, if the student is to learn to use identities in solving advanced mathematics problems.

In the traditional college mathematics course they start with the unit circle and from that they derive forty-three trigonometric identities. The technical institute student does not need to prove identities but he should know how to use them. This doesn't require at all the same treatment that is given in traditional courses.

The usual treatment of simultaneous equations in college math is not applications oriented. There is usually no discussion of the understanding of simultaneous equations as a statement of a real physical problem or the interpretation of the solution of a simultaneous equation and what it means. The average student who goes through this process comes out of it with absolutely nothing except a method for mechanically solving equations. He doesn't know what they mean. He doesn't know what the equations can do for him.

School I

TYPE: State Land Grant University

STATEMENT: Members of the Mathematics Faculty including the Head of the Mathematics Department.

The mathematics courses in the technology curricula are specially designed for students who are [sic] mathematics and science majors. Trigonometric identities are covered but not to the extent needed for higher mathematics.

School J

TYPE: State Land Grant University
Technical Institute Center

STATEMENT: Head of Mathematics Department

The topics covered in formal courses in algebra and trigonometry are essentially the same as would be covered in any college mathematics program. The emphasis on certain topics is probably different, however. We do not go deeply into such topics as: theory of equations, higher order determinants, progressions, and series. Trigonometric identities are not needed in our work to the extent that they would be covered in pure mathematics courses, leading to engineering or the physical sciences.

We feel that too much specialization of mathematics is undesirable, especially in beginning courses. The student can become so wrapped up in his field that he would not recognize applications in other fields.

Specialization is found in the two advanced courses taught for students in the electrical technologies. Analytic geometry and calculus are taught in these two courses using selected applications illustrating electrical circuits, characteristics, and electrical phenomena.

The methods of instruction used in mathematics courses are somewhat different from those used in the more traditional college mathematics classes. The technical institute student is not interested in theoretical mathematics. His mathematics has to mean something to him.

We make extensive use of applications as an aid to learning. Our applications come both from the textbook and from problems submitted by the several departments. It is in the use of applications that our instruction differs from general college mathematics.

School K

TYPE: Private Church Supported
University

STATEMENT: Head of Mathematics Department

The first and second semester courses in mathematics are general in nature since they serve all curricula. They are not designed especially for a particular curriculum. The algebra and trigonometry have much the same content as would be found in any college mathematics courses. Analytic geometry and calculus courses contain selected topics and are introductory in nature rather than comprehensive.

The primary difference between the mathematics program in the technical institute and the more traditional college courses is in the instructional methods used. We use applications where possible. This means that we cannot insist on a high level of competence in the manipulative skills of mathematics. It is more important for the technical student to be able to use a formula than to be able to derive it.

In the second and third term courses the topics are selected. Time does not permit a complete treatment of analytic geometry and calculus. This is particularly true in the electronics technology course where the applications are chosen almost entirely from practical electrical problems.

School L

TYPE: Private Technical Institute
Endowed, Non-profit

STATEMENT: Head, Mathematics Department

Mathematics courses for each technology cover the same topics. In the second and third semester courses, students are sectioned by technologies. This permits the use of selected applications in each section and special emphasis on topics that are most used in each technology.

One characteristic of the mathematics in technology curricula is a lack of time for the derivation of all equations. The objective must be to get the student to be able to use as many equations as possible with as good an understanding as possible of their origin.

The technical institute student is usually not interested in mathematics except as a tool. He is primarily interested in what mathematics can do for him.

Curve sketching is an example of applications in mathematics. Curve sketching has been introduced to help the student understand the significance of mathematical concepts. Example: We have one descriptive problem which synthesizes the work in graphical calculus. The data taken from an experimental rocket firing. The student is given the velocity; from this he determines the altitude, the acceleration, the interplay and relation of all factors, with a

number of answers being determined by slopes or by areas. The student finds that some methods are inherently more accurate than others--that a choice of methods is possible.

Adapted from Maurice William Roney, An Analysis of the Interrelationship of Mathematics, Science, and Technical Subject Matter in Selected Technical Institute Curricula (Doctoral dissertation, University of Maryland, 1964)

APPENDIX C

ANSWERS TO INTERVIEW QUESTIONS CONCERNING

QUALIFICATIONS OF MATHEMATICS TEACHERS

IN TECHNOLOGY CURRICULA

INTERVIEW NOTES

The following quotations are the answers given to Roney to the question, "Are mathematics teachers specialists in mathematics or are they drawn from the staff of the technology departments?" Six schools responded to this question.

School A

TYPE: State College

STATEMENT: Head, Technical Institute Mathematics and Physics Department

Mathematics teachers are not specialists in mathematics only--most have degrees in physics and also teach physics. We need a broader technical understanding on the part of our math teachers. We have no math specialists and we feel that this is very significant, in that the math can be related to the needs of the student in his technical study.

School B

TYPE: Community College

STATEMENT: Head, Mathematics Department

All mathematics instructors are members of the engineering staff and have engineering backgrounds. It is fundamental in the teaching of applied mathematics that the teacher understand and appreciate the need for mathematics and be also to answer questions about them. It would be extremely difficult for a teacher with only mathematics as a background to do this.

School F

TYPE: Community College

STATEMENT: Head, Mathematics Department

Our teachers are specialists in mathematics, although at some times it is necessary to borrow teachers from technology departments in order to handle heavy loads.

School H

TYPE: State Land Grant University, Technical Institute Division

STATEMENT: Head of Technical Institute Mathematics Department

We prefer to have mathematics taught by men with technical training rather than by mathematics majors. It is necessary to relate the mathematics to the solution of practical technical problems wherever possible. The technical student, generally speaking, is not interested in pure mathematics. Teachers who have only a mathematics background often cannot make the necessary applications.

School J

TYPE: State Land Grant University
Technical Insitute Center

STATEMENT: Head of Mathematics Department

Mathematics teachers are specialists. Most of our staff have majors in mathematics. We do not draw from the technology departments for our teachers.

School L

TYPE: Private Technical Institute, Endowed, Non-profit

STATEMENT: Head, Mathematics Department

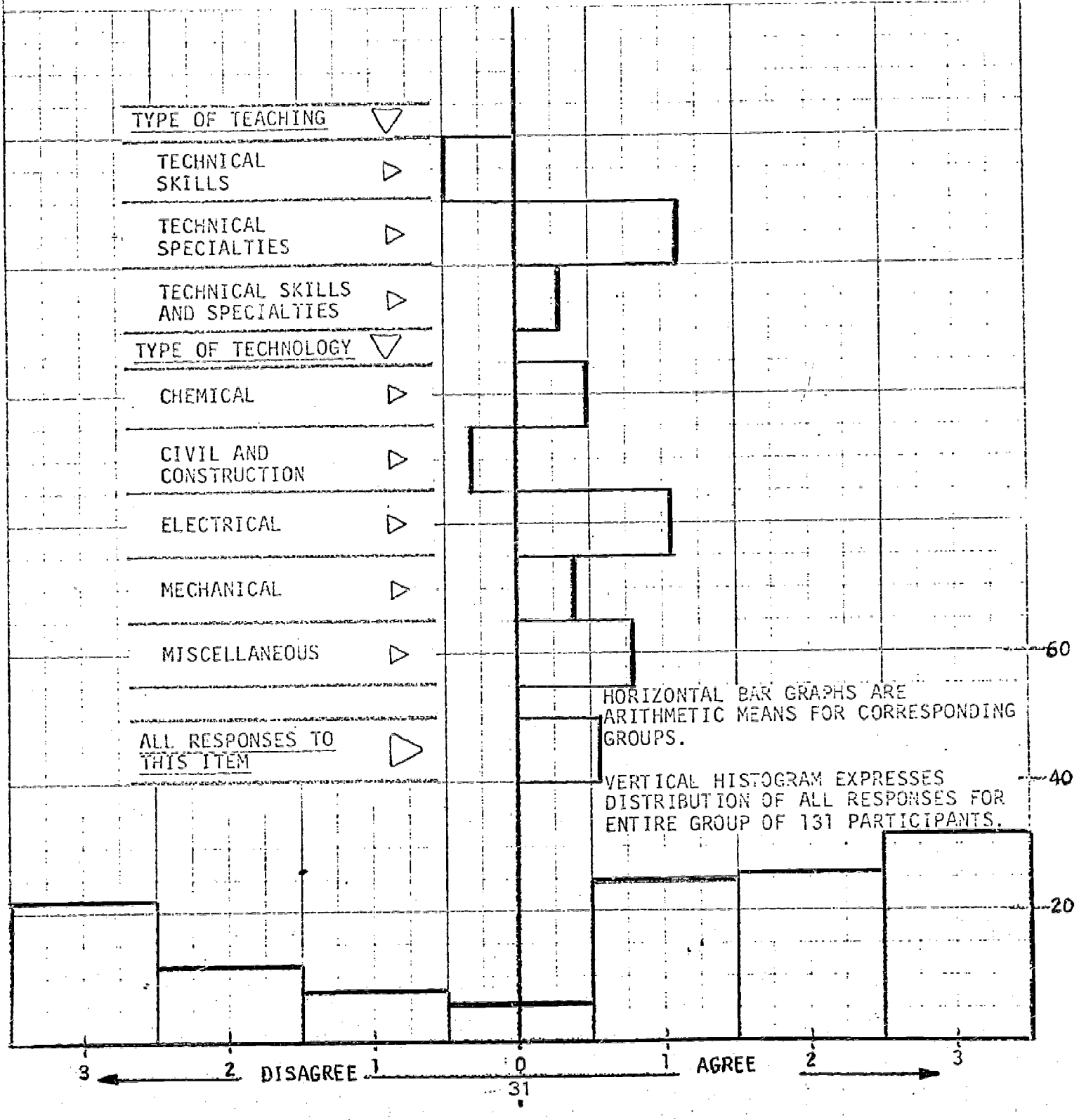
Most of the mathematics teachers have engineering education and experience. On occasion, teachers from technology departments teach mathematics classes. We prefer to have mathematics taught by men who have engineering backgrounds. Men who have only mathematics as a background often cannot relate the mathematics to the students' needs.

Adapted from Maurice William Roney, An Analysis of the Interrelationship of Mathematics, Science, and Technical Subject Matter in Selected Technical Institute Curricula (Doctoral dissertation, University of Maryland, 1964)

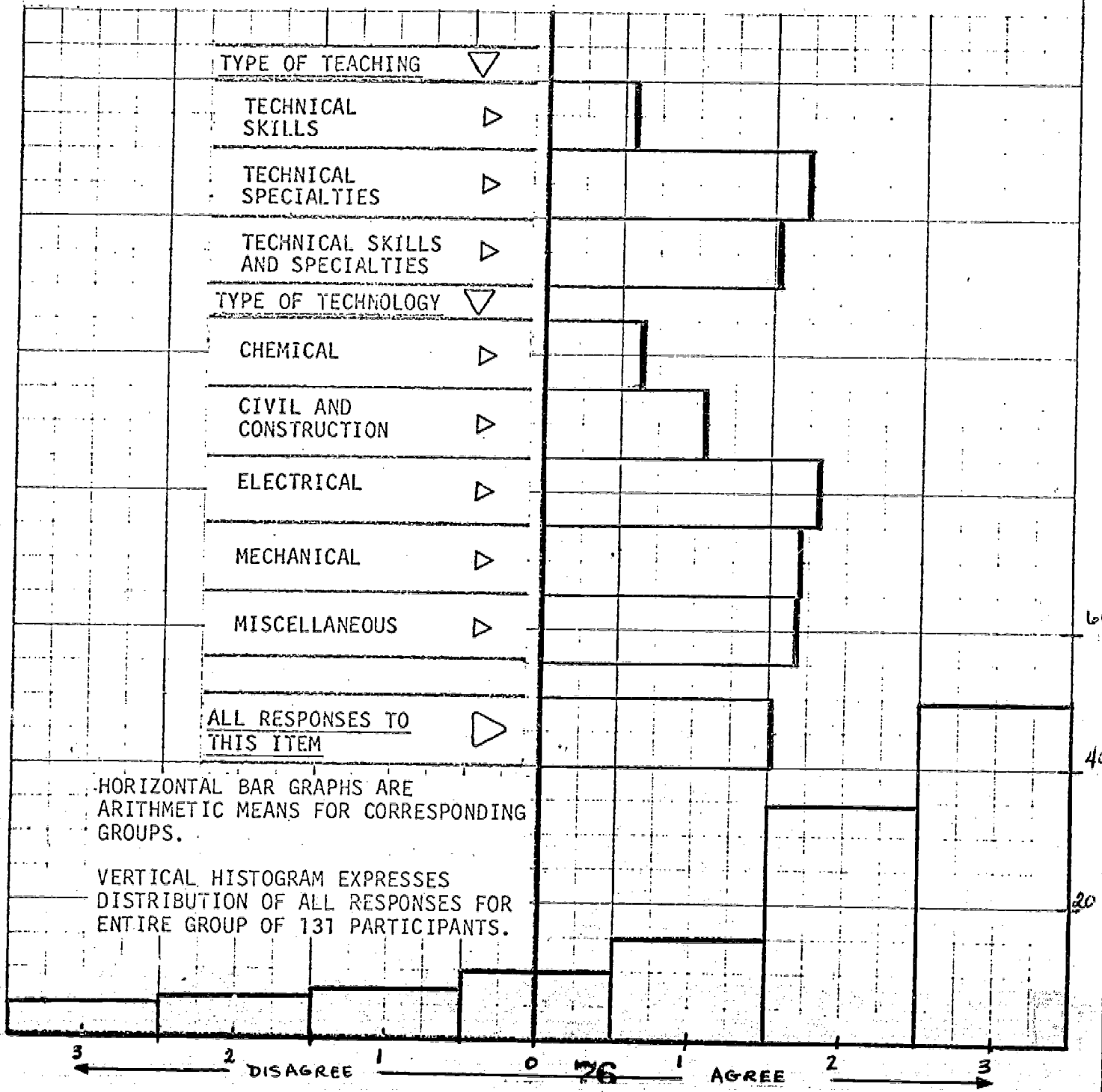
APPENDIX D

GRAPHS OF ANSWERS TO QUESTIONS CONCERNING DESIRABLE CHARACTERISTICS OF TEACHERS OF BASIC SCIENCE COURSES IN TECHNOLOGY CURRICULA

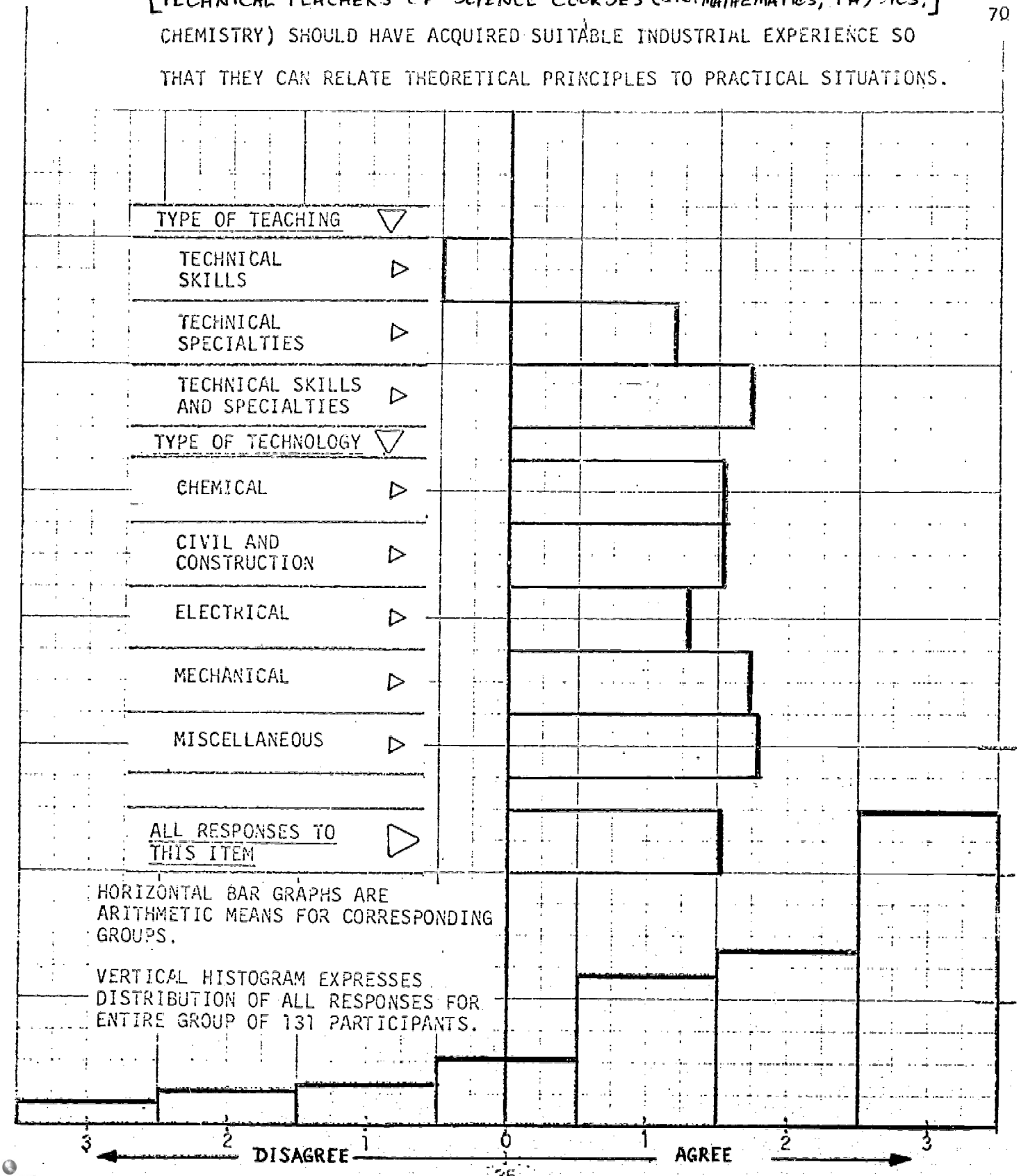
IV-1 TECHNICAL TEACHERS SHOULD BE VERSATILE ENOUGH TO SATISFACTORILY TEACH THE BASIC SCIENCE COURSES (E.G. MATHEMATICS, PHYSICS, CHEMISTRY) AS WELL AS THE TECHNICAL COURSES IN THEIR RESPECTIVE TECHNOLOGIES.



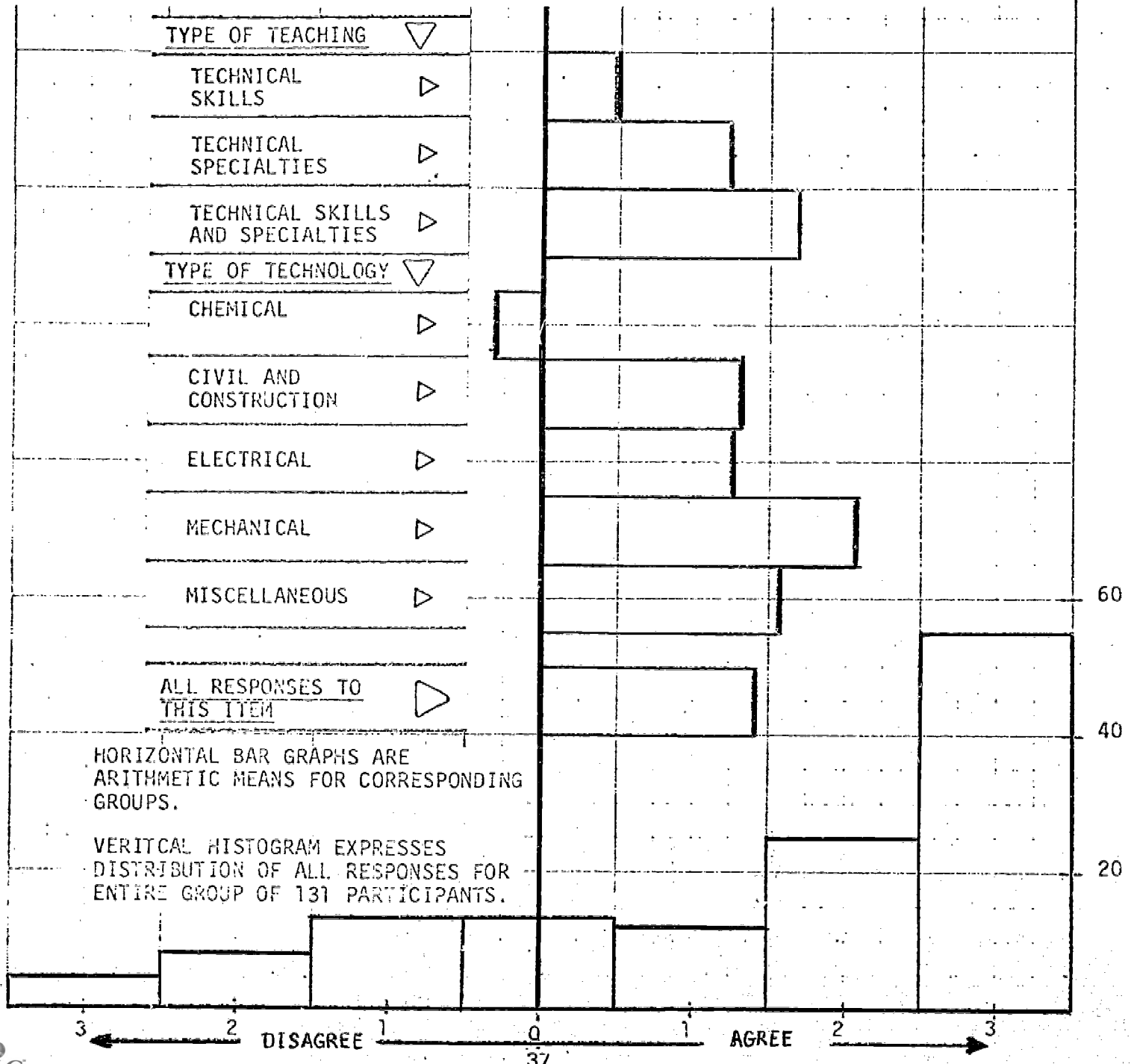
IV-4 IDEALLY, THE TECHNICAL TEACHER SHOULD HAVE A DEPTH OF MASTERY IN HIS TECHNICAL FIELD OF A TYPE AND LEVEL ROUGHLY EQUAL TO THAT OF THE MORE PRACTICAL UNDERGRADUATE ENGINEERING CURRICULUM WHICH PRECEDED THE ABSTRACT, HIGHLY THEORETICAL ENGINEERING CURRICULA SO PREVALENT TODAY.



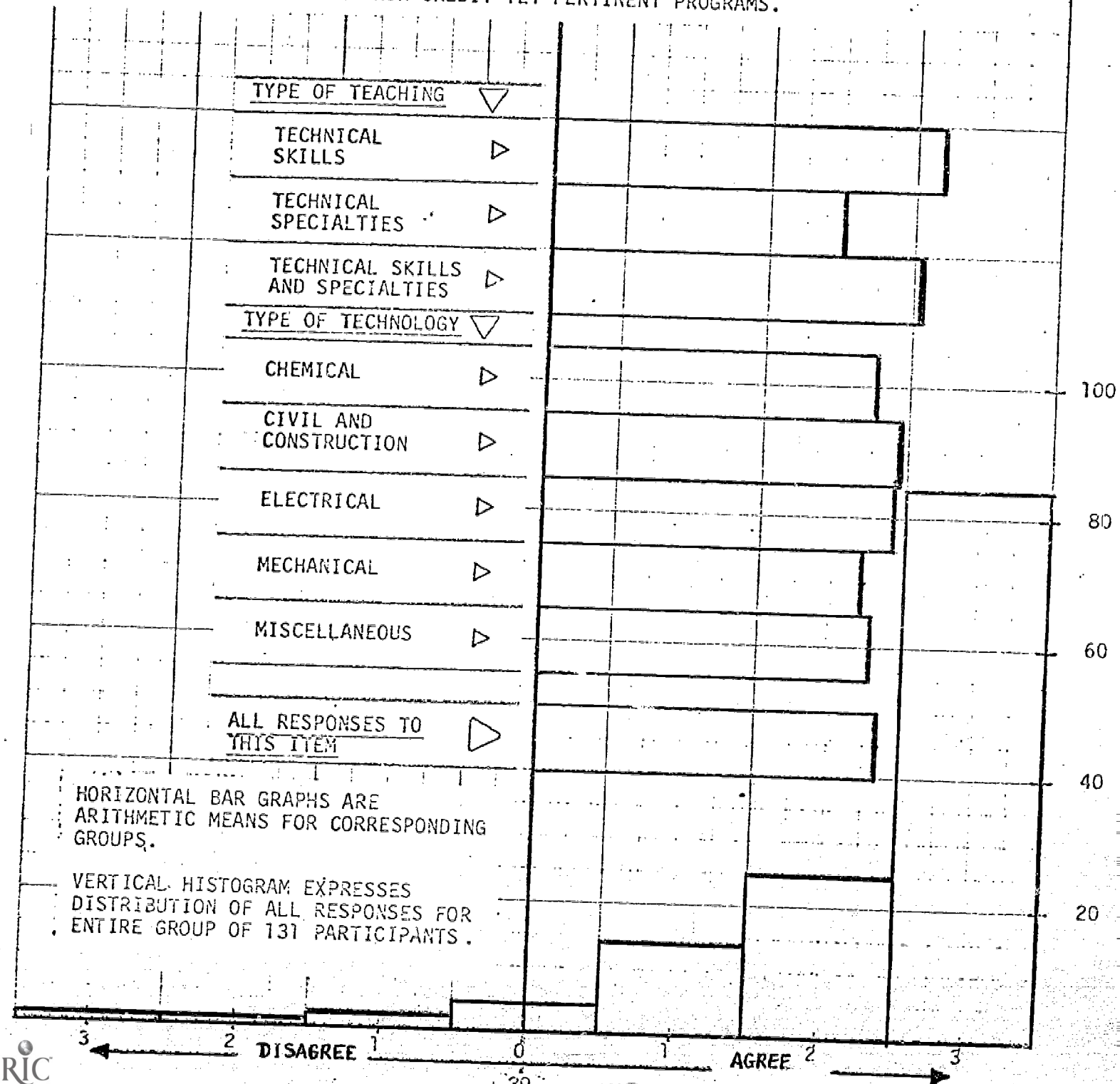
[TECHNICAL TEACHERS OF SCIENCE COURSES (E.G. MATHEMATICS, PHYSICS, CHEMISTRY) SHOULD HAVE ACQUIRED SUITABLE INDUSTRIAL EXPERIENCE SO THAT THEY CAN RELATE THEORETICAL PRINCIPLES TO PRACTICAL SITUATIONS.



IV-7 GRADUATES COMING DIRECTLY FROM COLLEGES CONFERRING THE BACHELOR'S DEGREE IN SCIENCE (E.G. MATHEMATICS, PHYSICS, CHEMISTRY) DO NOT QUALIFY TO TEACH TECHNICAL SUBJECTS IN ENGINEERING TECHNOLOGIES DUE TO LACK OF UNDERSTANDING AND PHILOSOPHY REGARDING THE OCCUPATIONAL ENVIRONMENT OF ENGINEERING TECHNICIANS.



IV-9 CRITERIA FOR ACCEPTING AND PROMOTING TECHNICAL TEACHERS SHOULD TAKE INTO ACCOUNT NUMEROUS CONSIDERATIONS SUCH AS IN-DEPTH INDUSTRIAL EXPERIENCE, TEACHING EXPERIENCE, PROFESSIONAL LICENSES, NSF INSTITUTES AND NON-CREDIT YET PERTINENT PROGRAMS.



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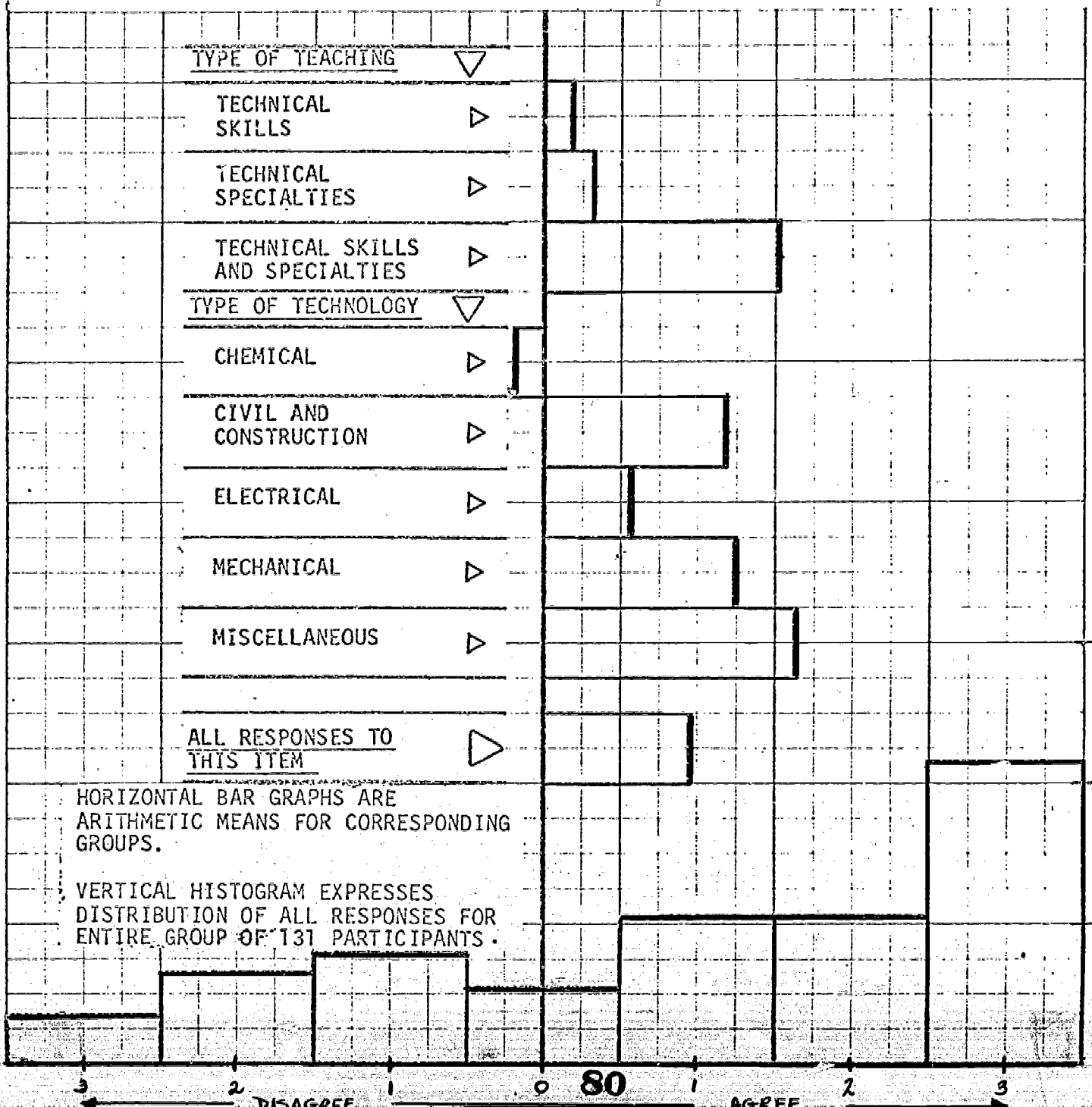
IV-10 CURRENT GRADUATES COMING DIRECTLY FROM ENGINEERING COLLEGES DO NOT QUALIFY TO TEACH TECHNICAL SUBJECTS IN ENGINEERING TECHNOLOGIES DUE TO LACK OF UNDERSTANDING AND PHILOSOPHY REGARDING THE OCCUPATIONAL ENVIRONMENT OF ENGINEERING TECHNICIANS.



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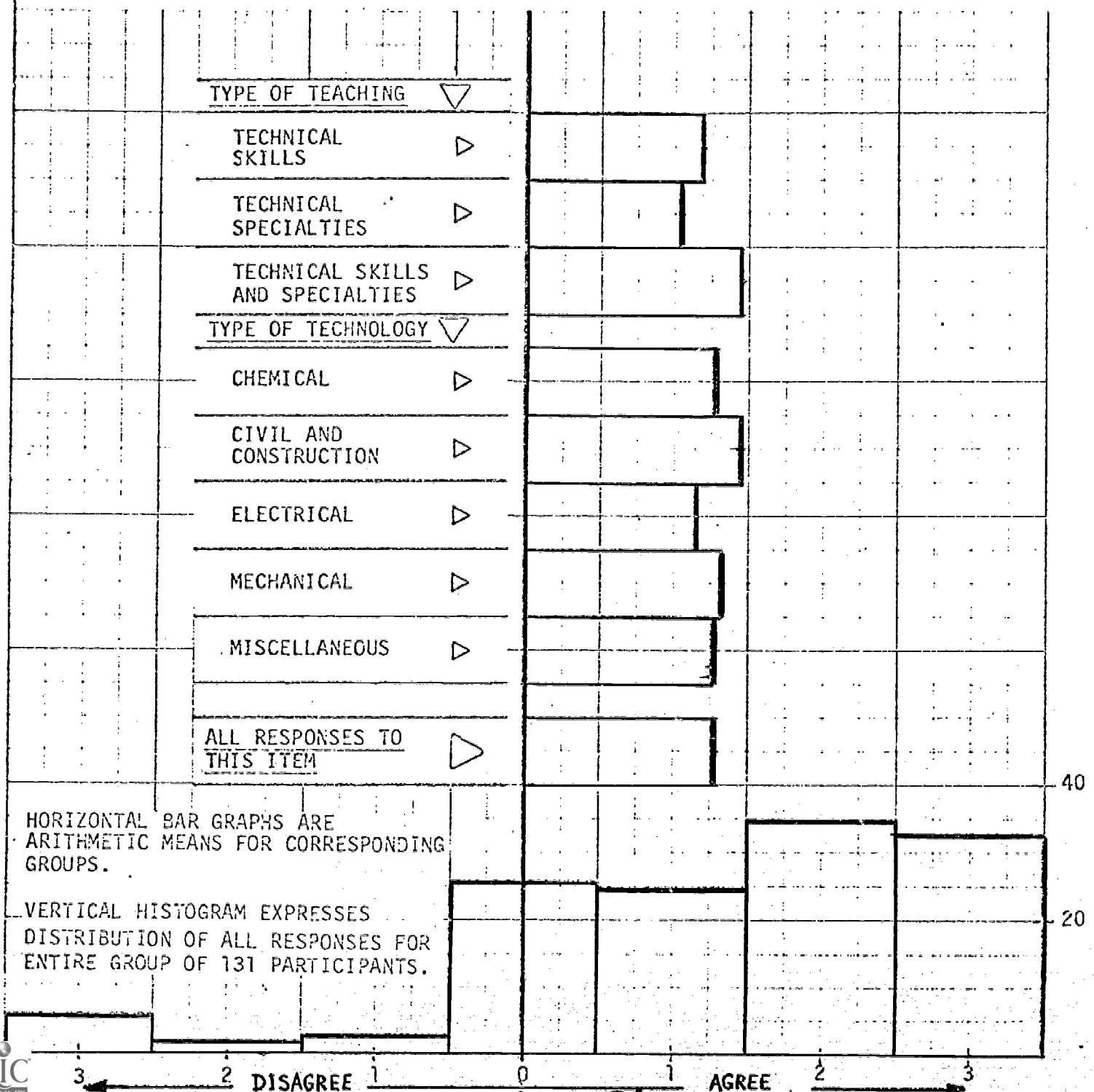
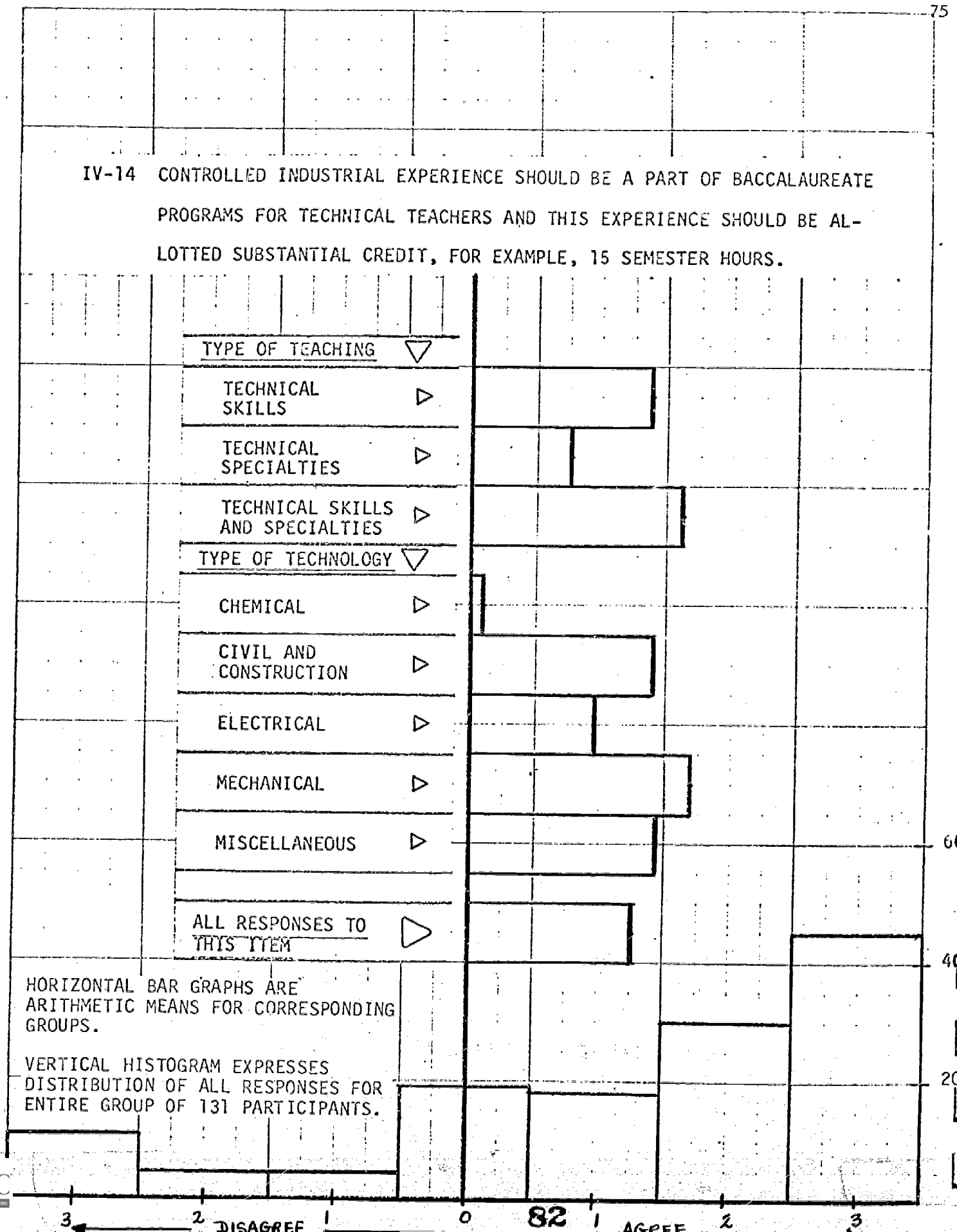
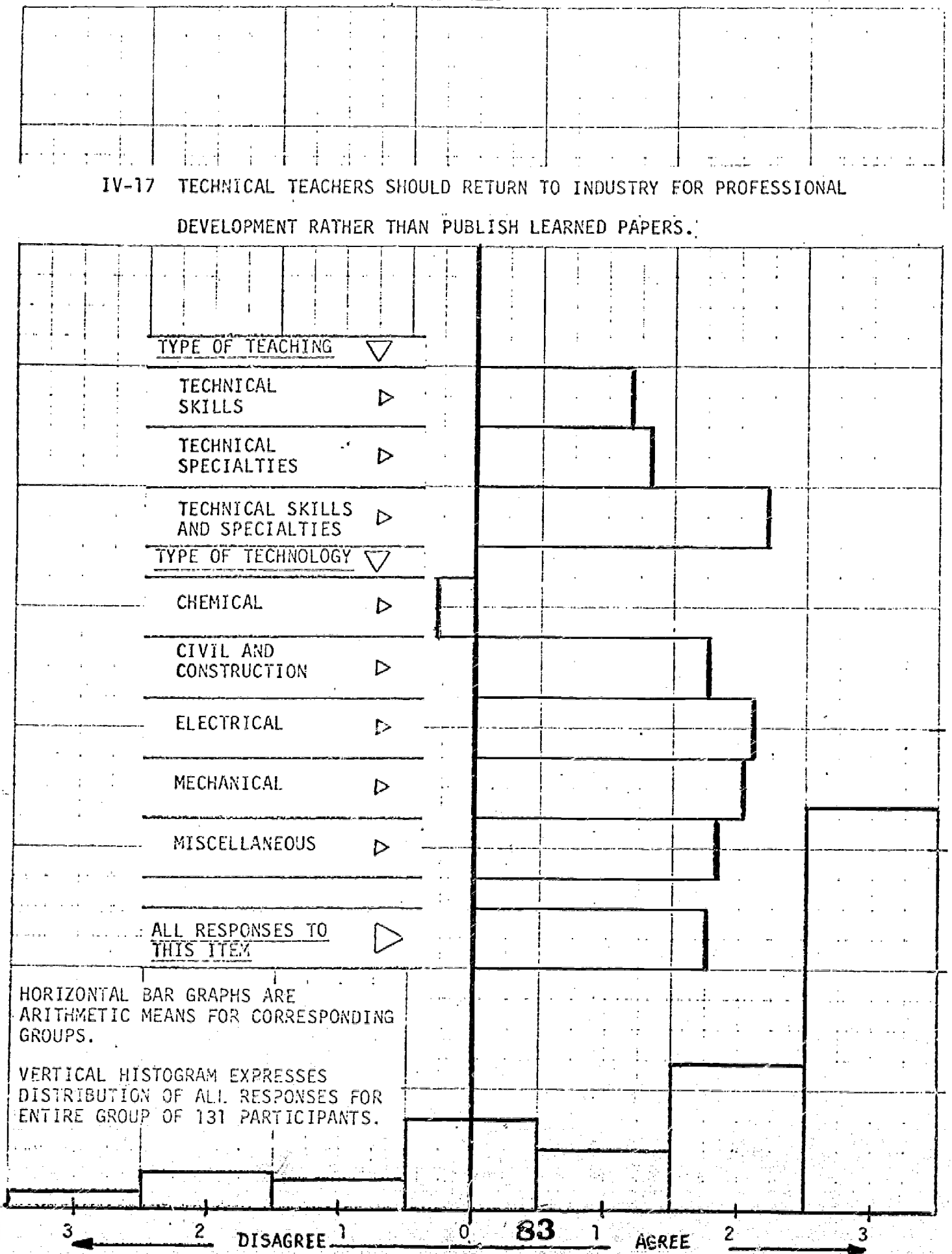
IV-13 APPROPRIATE INDUSTRIAL EMPLOYMENT SHOULD BE CONSIDERED DESIRABLE EXPERIENCE FOR PERSONNEL WHO TEACH NONTECHNICAL COURSES IN ENGINEERING TECHNOLOGY PROGRAMS.



IV-14 CONTROLLED INDUSTRIAL EXPERIENCE SHOULD BE A PART OF BACCALAUREATE PROGRAMS FOR TECHNICAL TEACHERS AND THIS EXPERIENCE SHOULD BE ALLOTTED SUBSTANTIAL CREDIT, FOR EXAMPLE, 15 SEMESTER HOURS.



IV-17 TECHNICAL TEACHERS SHOULD RETURN TO INDUSTRY FOR PROFESSIONAL DEVELOPMENT RATHER THAN PUBLISH LEARNED PAPERS.



APPENDIX E

PRELIMINARY SURVEY OF ILLINOIS JUNIOR COLLEGES:

QUESTIONNAIRE AND COVERING LETTER

ILLINOIS CENTRAL COLLEGE
PUBLIC JUNIOR COLLEGE DISTRICT NO. 514
P.O. BOX 2400 • EAST PEORIA, ILLINOIS 61611 • TELEPHONE: (309) 694-1421

July 30, 1970

Dean of Instruction
Wabash Valley College
2222 College
Mount Carmel, Illinois 62863

Dear Sir:

In connection with my graduate study at Bradley University, I am currently conducting a study of the practices in Illinois Junior Colleges regarding the mathematics and physics courses offered for students in engineering and industrial technology programs. My immediate interest is in finding out whether technical or applied courses in mathematics and physics are offered in junior colleges, and if so, in what department.

As the study progresses, I hope to explore the opinions and experience of instructors in both the technology and academic departments, and the attitudes and aspirations of selected students in each of these areas. All questionnaires can, of course, be prepared anonymously.

The cooperation of your school in this study would be most helpful in developing a comprehensive picture of current practices in Illinois. I would very much appreciate the completion and return of the enclosed questionnaire. A place is provided for you to indicate whether you would be willing to participate in the later phases of the study described above.

Very truly yours,

Mrs. Richard Doversberger, Instructor
Engineering and Industrial Occupations Division

Questionnaire Concerning Mathematics and Physics Courses
for Technology Programs

1. Does your school offer technical or applied math for engineering and industrial technology students? yes_____ no_____

2. If such courses are offered, in what department are they taught?
   Mathematics Department_____ Technology Department_____

3. Does your school offer technical or applied physics for engineering and industrial technology students? yes_____ no_____

4. If offered, in what department are they taught?
   Science Department_____Technology Department_____

5. Is industrial experience sought in hiring instructors
   to teach technical math?_____ to teach technical physics?_____

6. Are you willing to participate in later phases of this study

   a) by distributing questionnaires to students in selected classes in engineering and industrial technology and in transfer curricula (sample sizes of about 50 desirable)?
      yes_____ no_____

   b) by distributing questionnaires to instructors in math, science, and engineering and industrial technology departments?
      yes_____ no_____

7. Would you like to receive a summary of this study?
   yes_____ no_____

Name of School_____

Approximate full-time enrollment_____

Names of persons to whom future correspondence should be directed

_____

_____